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ONE OF THE LARGEST RELIEF MAPS IN THE WORLD has been made by Mr. EDWIN E. HOWELL, of Washington, D. C., and is now on exhibition at his museum on Fifteenth St. It is molded on a section of a globe 160 ins. (13⅓ ft.) in diameter and represents the United States. Mr. HOWELL prepared this model chiefly from data furnished by the great wall map of the United States published by the U. S. Geological Survey, on which the topographic relief of the country is shown in 500 and 1,000-ft. contour intervals. For the coast line the material was obtained from the maps of the U. S. Hydrographic Office and the U. S. Coast and Geodetic Survey. The model is 6 ft. 6 ins. by 4 ft. in size, and the horizontal scale is 1 in. to 50 miles, with a vertical scale of 1 in. to 5 miles. Mr. HOWELL is now preparing a similar map for the Director of the U. S. Geological Survey for exhibition at Chicago in 1892. This map will be on a slightly larger scale, or 1 in. to 40 miles horizontal, and 1 in. to 2½ miles vertical scale. The vertical relief will be thus less exaggerated. We are indebted to Mr. H. M. WILSON, of the U. S. Geological Survey, for this information.

PUBLIC WORKS IN OMAHA, NEB., were voted for by the citizens on Nov. 3, and approved by a large majority, as follows: For the completion of a city hall, now under construction, $175,000; public library, $100,000; street intersections, paving, $50,000; sewer bonds, $50,000; park bonds, $400,000, and the purchase of school sites, $78,400, and erection of school buildings, $306,600. Mr. GEORGE W. TILLSON, the City Engineer, writes us that these improvements will be rapidly carried to completion. The debt of Omaha, with a population of 140,000, is now less than $2,000,000.

A DRY-DOCK AT SUPERIOR, WIS., is to be built by the American Steel Barge Co. at a cost of $250,000. It will be 500 ft. long, 100 ft. wide and 20 ft. deep. Mr. George E. HARTMAN, engineer of the Cleveland Vessel Owners' docks, will design the structure. It will be used in building and repairing vessels of the whaleback type.

THE TOPEKA DAM is under construction, and the contractors for the masonry, Messrs. Comstock & Williams, of Kansas City, are getting out the dimension stone required and are arranging quarters for their men and collecting plant. The length of the dam will be 852 ft. with an 80 ft. gate on the north side; the practical head secured will be 14 ft. The two power-houses will utilize by 78-in. turbines and dynamos about 5,000 HP. as a minimum, with 8,000 HP., possible, says the Topeka *Capitol*.

A NEW TYPE OF ELECTRIC RAILWAY, which seems to have some strong points in its favor, has been devised by Mr. W. B. VANSIZE, of Plainfield, N. J. A series of secondary or storage batteries are placed in cellars or other out of the way places, at intervals of ¼ to ½ mile, connected with a high tension charging circuit which has nothing to do with the railway directly. The track is divided up into corresponding insulated "working circuits," in which the rails are the conductors. By connecting the secondary battery with the charging circuit in series and with the working circuit in multiple arc the high tension charging current is converted into a very low-tension working current, which has small tendency to escape even if the insulation be very imperfect. The length of the sections can be varied according to the grades or traffic so as to exhaust the batteries equally. It is claimed that in this way the difficulties incident to the use of the rails as conductors can be completely and effectively overcome.

THE CONSTRUCTION OF THE BANGKOK-KORAT RAILWAY, in Siam, says *Engineering*, is bid for by Campbell & Murray, a Singapore firm, for $1,000,000. This firm is backed by Jardine & Mathieson, of London. The railway will be 165 miles long, and is to be completed in 1896. It will be broad gage, the capital is not to exceed $8,000,000, half of which is subscribed for by the royal family, and the Siamese government guarantees 5 per cent. for the first 10 years of operation. The estimated cost of construction is about $32,500 per mile.

A BRIDGE ACROSS THE MISSISSIPPI, at Alton, Ill., is projected. The purpose is to connect the eastern and western lines of the Burlington system, and give a more direct line to St. Louis. It is understood the Chicago, Burlington & Quincy and the C., C., C & St. L. railways are back of the project.

A MOUNTAIN CABLE RAILWAY COMPANY has been organized to build a road from the terminus of the Catskill Mt. Railway up the mountain to a point near the Catskill Hotel.

THE FIRST MOVEMENT BY STEAM ON A RAILWAY in the State of New Jersey was celebrated at Bordentown on Nov. 12 by the management of the Pennsylvania Railway Company. The occasion was the 60th anniversary of the laying of the first piece of track on the Camden & Amboy railway on Nov. 12, 1831, and a massive monument of granite has been erected to commemorate the event. The address of presentation was made by Mr. JOSEPH T. RICHARDS, Asst. Chf. Engineer, Pennsylvania R. R., and the monument was accepted by Mr. F. WOLCOTT JACKSON, Gen. Supt. of the United Railroads of New Jersey. Mr. J. ELFRITH WATKINS, of the U. S. National Museum, Washington, D. C., delivered an historical address on the Camden & Amboy Railway.

THE SECOND-CLASS OF PASSENGER TRAFFIC has been abandoned by the Great Northern Railway of England, but for the present second-class tickets will be sold to certain stations on connecting lines of other companies. The Midland Railway was the first to start this movement some years ago, and the Manchester, Sheffield & Lincolnshire Railway and some of the Scotch lines have already followed the example. The abandoning of this class has been considered by most of the important companies.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a derailment on the New York, Lake Erie & Western R. R. at Adrian, N. Y., Nov. 11. The engine driver was killed and three or four passengers were slightly injured. The baggage and smoking car was burned, and the day car badly damaged. The track at that point is laid with 80-lb. rails. A train of two cars ran away on the Mount Penn gravity railway at Reading, Pa., Nov. 5, and jumped the track at a curve. One person was killed and 4 were injured. It is thought that wet leaves on the track caused the wheels to slide, and so prevented the brakes from acting.

A SERIOUS RAILWAY ACCIDENT occurred near Nagpur, India, Nov. 4. The tire of a driving whee of the engine broke, and the train was derailed Ten persons were killed and about 30 injured.

AN ALUMINUM STEAM LAUNCH has been built in Zurich, by Esher, Wyss & Co., manufacturers of aluminum. The hull, rudder, screw and engine house are constructed of the new metal, and the weight of the whole boat, including engine, boiler, copper pipes and anchor, is 880 lbs. Aluminum is also being successfully used in New York for the sounding boards of stringed musical instruments, the metallic tones produced by the use of other metals for this purpose being conspicuously absent. The German government has also placed an order with the Pittsburg Reduction Co. for several hundred tons of aluminum for military accoutrements.

TWO SOLID WOOD PASSENGER CARS are being made in Tulare Co., Cal., for exhibition at Chicago in 1892. They will be made from the trunk of a *sequoia gigantea*, shaped to the outward form of cars, and then hollowing out and finishing in the interior, with its seats, etc. The whole car will be polished.

A TRACKMEN'S TRAIN APPROACH INDICATOR OR SIGNAL has been invented by Sir WM. ARROLL, of England. The idea was suggested to him by an accident near Glasgow in which 5 trackmen were run over and killed by an express train which came upon them unexpectedly. The device consists of a small electrical apparatus which is temporarily fixed beside one of the rails at a sufficient distance in advance of the point where the track is under repair. An electric bell connected with this apparatus is placed near the men. The wheel tires of an approaching train depress a spring attached to the electric appliance and complete a circuit which sets the bell in motion, and so warns the trackmen of their danger. The apparatus has not been patented, and costs about $12.50. It has been successfully tested on the North British Railway.

ELECTRIC LIGHTING for cars and a tunnel 2 miles long is proposed by the Rhondda & Swansea Bay Railway Co., of England. Water power would be used for generating the current.

BELGIAN LOCOMOTIVE PRACTICE was described in a paper recently presented before the Society of Engineers, Germany. For several years the Belgian State Railways have used nothing but dust coal in the locomotives, the grate areas of the older engines ranging between 27 and 32 sq. ft., and the grate bars being closely spaced. Owing to the increased train loads, however, and the demands for higher speed the newer locomotives have been given a grate area of about 54 sq. ft. Thin fires are maintained, and the coal dust is used in a pretty wet condition, being introduced in comparatively small quantities at a time. There is said to be no difficulty in making steam, and the fireboxes last from 10 to 12 years, during which time the tube sheets are generally removed once. Leaky tube ends are said to be unknown. In the newer locomotives the forward axle boxes are of the radial type, and give little satisfaction, imparting a jerky unsteady motion to the engine.

AN OIL-PIPE LINE from Pittsburgh to Philadelphia is said to have been surveyed in the interest of a rival to the Standard Oil Co. The estimated cost for a line of 40,000 barrels daily capacity is $1,000,000. Mr. ANDREW CARNEGIE is reported as one of those interested.

THE GREAT IMPROVEMENT IN GAS BURNING APPLIANCES which has taken place since the use of gas for fuel became common, was well illustrated at the exhibition held in connection with the recent annual convention of the American Gas Light Association. The exhibition was held in a basement room of the Scottish Rite Hall in New York City. The room had a low ceiling and rather poor facilities for ventilation. All the exhibition space was crowded with gas stoves and burners of all makes and types; yet when all of them were in full blast there was no noticeable odor in the room, as would have been the case with the gas stoves offered to the public but a short time ago.

Tank Locomotive for Heavy Grades, and Saloon Car; New Zealand Government Railways.

(WITH INSET.)

We illustrate this week a type of double-end tank engine designed by Mr. T. F. ROTHERAM, M. Inst. C. E., Locomotive Superintendent, New Zealand Government Railways, for use on divisions having steep grades and sharp curves. The general view, Fig. 1, reproduced from a photograph, represents one of two engines with driving wheels 3 ft. diameter, which has been working on the Wellington Railway, doing excellent duty. Up to the end of July, 1891, this engine had been running for 16 months on grades of 1 in 33 (3%), with curves of 330 ft. radius, some of these being reverse curves. The working train load up this grade is 125 gross tons, exclusive of the engine. The weight of the engine in working order, with tanks and bunkers full, is 36 gross tons, with 5¼ tons on each truck axle, and 8½ tons on each coupled axle. The performance of these engines was so satisfactory that others have been built, and the drawings on our inset sheet are for two engines which were being erected in July last at the railway works at Christchurch, and which have driving wheels 3 ft. 3¾ ins. in diameter. They are to be used on the railway between Wanganui and Palmerston North, on which there are grades of 1 in 33 (3%). New Zealand has about 1,950 miles of railway, all of 3 ft. 6 ins. gage.

The engines have cylinders 14 × 20 ins., which are placed outside the frames. The steam chests are on top of the cylinders, and balanced slide valves are used. The Walschaerts type of valve gear has been adopted, and particular attention has been paid to insure large wearing surfaces. The frames are of steel plates, ⅜ in. thick, and 36¼ ins. apart. The truck frames are of the ordinary bar type. Care has been taken to reduce as far as possible the time and labor which constant attention to lubrication necessitates, and where possible all working parts are supplied from oil reservoirs so situated that the siphons can easily be drawn when lubrication is not required. The cylinders are fed from a sight feed lubricator placed in the cab. The piston rods and valve spindles are provided with metallic packing. There are two influx injectors, one on each tank, the waste water being carried down to the ashpan. The boiler is of the Belpaire type, constructed of Lowmoor iron ⅞ in. thick. The barrel is 3 ft. 6 ins. diameter inside the smallest ring. It is single riveted in the circumferential joints, and double zigzag riveted in the longitudinal butt joints. The working pressure is 160 lbs. per sq. in. The firebox is of copper, and stayed in the usual manner. The ashpan is fitted with perforated doors and dampers. The smokebox is 3 ft. 4 ins. long, with the smokestack near the tube plate, and a large headlight on the extension front. The smokestack (which is in one piece), smoke-box front and door are of cast iron. The tanks are on each side of the boiler. A large and roomy cab is provided, behind which is the coal bunker. A rear headlight is carried on brackets attached to the bunker.

The engines are carried on 6 coupled driving wheels, 3ft. 3¾ ins. diameter, with a two-wheel or Bissell truck at each end. The truck axles have outside bearings. The truck wheels are 2 ft. 4½ ins. diameter, and the truck radius is about 5 ft. 9 ins. All the wheels, with the exception of the driving wheels which are flangeless, are fitted with a water service, which is in constant use and has given excellent results. Two pair of wheels are fitted with the Gresham & Craven sanding apparatus, supplied from two sand-boxes. The wheels are compensated throughout into two systems. The leading system includes the leading truck and leading coupled wheels. The trailing system includes the driving and trailing coupled wheels and trailing truck. This practice of thorough compensating has been found very desirable on these roads, and the result has been that the engines run with remarkable smoothness and flexibility, while wear of tires and all wearing parts is reduced to a minimum. A simple brake gear has been adopted which can be applied by hand or steam, both acting on the same lever. A single adjusting nut only is required, and one great advantage in this gear lies in the fact that a new brake shoe may be placed on any one wheel without necessarily renewing the others, and without needing any adjustment. There is a brake shoe on the forward side of each coupled wheel. A central combined coupling, drawbar and buffer is used, and an American style of pilot is fitted to each end.

Six passenger locomotives of a somewhat similar type, known as double-end mogul engines, but without tanks, were built for the New Zealand railways by the Baldwin Locomotive Works, of Philadelphia, Pa., in 1885. Six consolidation freight engines were built at the same time. The passenger engines have six coupled driving wheels and a Bissell truck, with outside bearings, at each end. The smokebox has no extension front, but the smokestack is of balloon pattern, fitted with a spark arrester. American style bar frames were used, and the cylinders were outside. The cylinders were 15 × 20 ins., and the driving wheels 48 ins. diameter. Weight on driving wheels, 50,540 lbs.; total weight of engine, 65,840 lbs.; weight of engine and tender, 100,800 lbs. The tenders were carried on a pair of four-wheel trucks. The Westinghouse air brake was applied to all driving and tender wheels. One of these double-end mogul engines is illustrated in Fig. 2. Prior to this, in 1879, the Baldwin Locomotive Works had built six consolidation engines, with cylinders 15 × 18 ins., for these railways.

The dimensions of the engines are given in the following table, those of the American engines having been furnished us by the Baldwin Locomotive Works.

We also illustrate a novel type of saloon car for these railways, designed to meet the requirements of the service, and to render railway traveling, particularly the long and tedious journeys, much more comfortable and convenient. Several of these cars have been built at the New Zealand railway shops to the designs of Mr. ROTHERAM, the Locomotive Superintendent, to whom the general idea was suggested by Mr. J. P. MAXWELL, one of the Railway Commissioners. They are now in regular service on the main lines of the North and South islands. A view of one of these cars is given in Fig. 3, and the drawings are given on the inset sheet.

Each car is 39 ft. 7 ins. long over the platforms, 8 ft. wide outside, 6 ft. 8½ ins. high at the side outside, and 8 ft. high from the floor to the top of the monitor roof, which is 2 ft. 11 ins. wide inside. The main underframes consist of two channel irons placed back to back and 4 ft. 8 ins. apart. The body carried on a pair of four-wheel trucks, with wheels 2 ft. 8 ins. diameter. Truck wheel base, 4 ft. 10 ins.; distance c. to c. of trucks, 26 ft. 6 ins. The wheel gage is 3 ft. 3¼ ins. between tire flanges. A combined coupler and buffer is used, with two safety chains. There is a platform 2 ft. 6 ins. wide at each end, over which the roof projects, the hood being supported by four light iron posts. At one end of the body is a general compartment or saloon 15 ft. 6¼ ins. long, and the whole width inside, 7 ft. 1 in. This is entered at each end by a door in the middle.

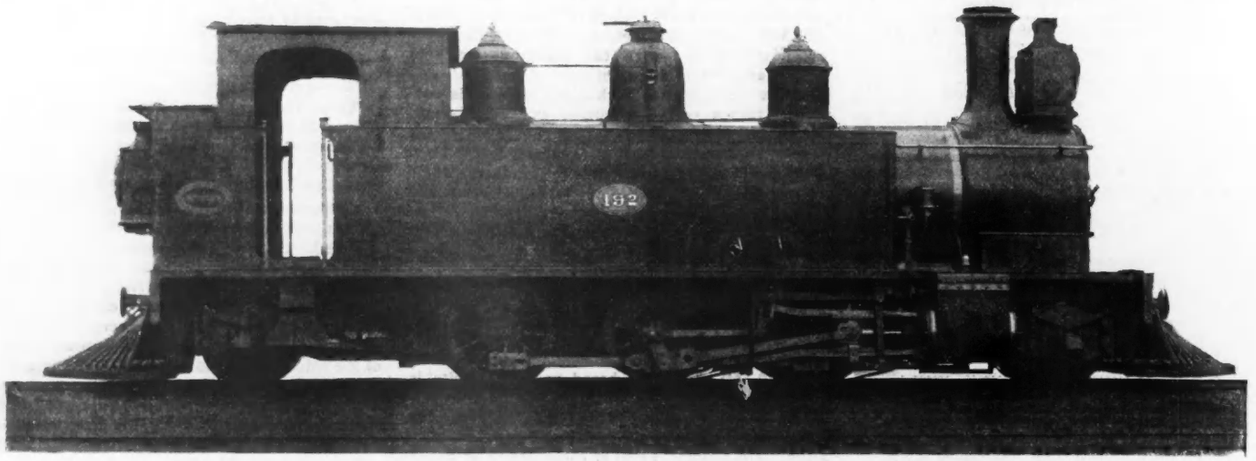

FIG. 1. DOUBLE-END TANK LOCOMOTIVE FOR HEAVY GRADES; NEW ZEALAND GOVERNMENT RAILWAYS. T. F. Rotheram, M. Inst. C. E., Locomotive Supt.

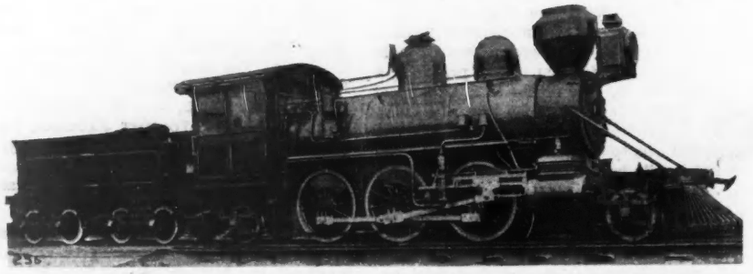

FIG. 2. DOUBLE-END LOCOMOTIVE FOR THE NEW ZEALAND GOVERNMENT RAILWAYS. Baldwin Locomotive Works, Philadelphia, Pa.

Adjoining this is a lavatory and water-closet, about 5 ft. long. The rest of the body is divided into two first class compartments, 6 ft. 4⅝ ins. between partitions, and 4 ft. 11½ ins. wide inside. Along one side of the car, and for rather more than half the length of the body, is a gallery 2 ft. 2½ ins. wide, which is formed by the difference in width between the general and the smaller compartments. This gallery, which is accessible from all the compartments, is under the roof, and has an ornamental iron railing for the protection of passengers, while a glass door at the platform end affords protection from wind, dust, &c. The railing appears to be unnecessarily high, rather spoiling the appearance. A filter is carried in a recess let into the corner of the lavatory and is available from the gallery. All fittings for doors, windows, lamp and hat brackets, etc., also those of the lavatory, are electro-plated. There are four lamps hung from the monitor roof. Baggage racks for light articles are placed along the sides of the general compartment and the partitions of the smaller compartments. The lavatory has a double lining all round, the intervening space being packed with silicate wool or asbestos. It is entered from the platform. It is fitted with a wash basin and a combined water-closet and urinal. Water is supplied from a tank carried in the roof overhead. It is lighted by a ship's candle or swinging bracket attached to the partition. No provision is made for heating these cars, as the climate does not require it.

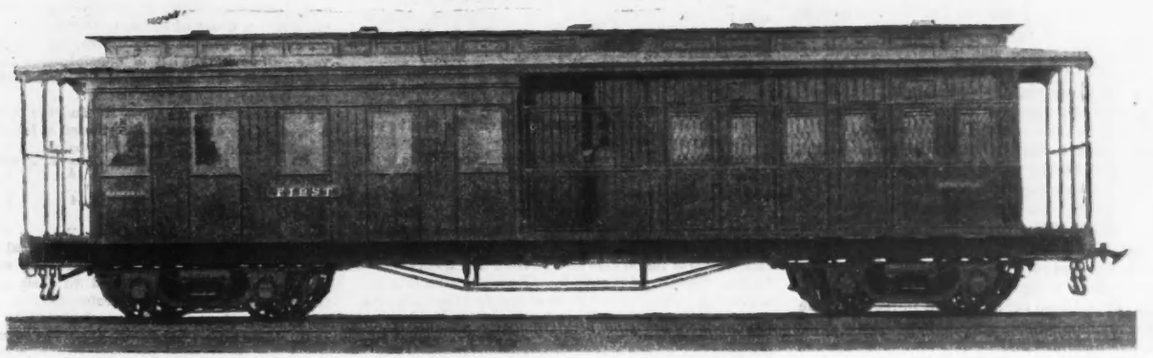

FIG. 3. SALOON CAR; NEW ZEALAND GOVERNMENT RAILWAYS.

The general compartment or saloon is intended to carry 20 passengers, and is provided with 5 double reversible seats on one side and one long seat extending the whole length of the compartment upon the other side. The inside is neatly paneled in light and dark woods, without the contrast being too decided. The seats are comfortably upholstered in buffalo hide, and the floor is covered with thick coir mats. The small first-class compartments accommodate 8 passengers each, and one of these compartments is for the convenience of smokers. They are finished and upholstered to correspond with the general compartment, and each is also provided with a small table, which when closed up forms an ornamental panel under the center window opposite the door. Provision is made for filling up the space between the seats, and the cushions can be laid across the compartment, thus forming a fairly comfortable substitute for a bed. The total seating capacity of the car is for 36 passengers. The total weight is 12 gross tons (26,880 lbs.), or 746.6 lbs. per passenger. The exterior is painted Indian red, picked out with black and fine lined with yellow.

DIMENSIONS OF NEW ZEALAND AND AMERICAN LOCOMOTIVES FOR THE NEW ZEALAND GOVERNMENT RAILWAYS.

	N'w Zealand engines, 1890.	Baldwin engines 1885.
Cylinders	14 × 20 ins.	15 × 20 in.
Diam. of driving wheels	3 ft. 3¾ ins.	4 ft. 0 ins.
Diam, of truck wheels	2 ft. 4½ ins.	2 ft. 4½ ins.
Diam. of boiler	3 ft. 6 ins.	4 ft. 2 ins.
Form of boiler	Belpaire.	Straight.
Boiler pressure	160 lbs.	140 lbs.
Size of firebox	66 × 35½ ins.	{81¼ × 29 × F. 50 B 39. 1/2}
Tubes, number	144	
Tubes, diameter	1¾ ins.	2 ins.
Tubes, length	10 ft. 3¼ ins.	9 ft. 5 ins.
Heating surface, tubes	680 sq. ft.	826 sq. ft.
Heating surface, firebox.	60 sq. ft.	87⅛ ft.
Heating surface, total	740 sq. ft.	913⅛ ft.
Grate area	12¼ sq. ft.	
Wheel base, rigid and driving.	8 ft. 6 ins.	9 ft. 6 ins.
Wheel base, total	21 ft. 9 ins.	23 ft. 2 ins.
Weight on driving axles	[1]57,120 lbs.	50,540 lbs.
Weight on truck axles	[2]23,520 lbs.	
Weight, total	80,640 lbs.	65,840
Weight of tender		32,000
Capacity of tanks (U. S. galls.).	[3]960	[4]1,600
Capacity of coal and lumber	70 cu. ft.	[4]4 tons.
Height from rail to top of smokestack	11 ft. 0⅛ in.	
Length over frames	26 ft. 7 ins.	
Width over all	7 ft. 10 ins.	
Diameter of tender truck wheels		2 ft. 4½ ins.

[1] 19 040 lbs. on each; [2] 11,760 lbs. on each; [3] 800 imp. galls; [4] tender.

The inside is neatly paneled in light and dark woods, without the contrast being too decided. The seats are comfortably upholstered in buffalo hide, and the floor is covered with thick coir mats. The small first-class compartments accommodate 8 passengers each, and one of these compartments is for the convenience of smokers. They are finished and upholstered to correspond with the general compartment, and each is also provided with a small table, which when closed up forms an ornamental panel under the center window opposite the door. Provision is made for filling up the space between the seats, and the cushions can be laid across the compartment, thus forming a fairly comfortable substitute for a bed. The total seating capacity of the car is for 36 passengers. The total weight is 12 gross tons (26,880 lbs.), or 746.6 lbs. per passenger. The exterior is painted Indian red, picked out with black and fine lined with yellow.

We are indebted to Mr. ROTHERAM, M. Inst. C. E., Locomotive Superintendent, New Zealand Government Railways, for drawings, photographs and particulars of the engine and car illustrated in this article. It may be interesting to note here that Mr. T. BACK, General Manager of the Tasmania Railways, has had two sleeping cars built in that colony for service between Launceston and Hobart.

The Prevention and Reclamation of Alkaline Lands.

Experience in this and other countries has shown that land irrigated with certain waters are gradually rendered valueless by the increasing presence of alkali in the soil. Other lands remain idle and useless because of the alkali already present. In a paper recently read before the Polytechnic Society, of Utah, Mr. H. SCOUGALL, C. E., of Salt Lake City, discusses the prevention of the increase of alkili and the removal of it where it already exists.

Mr. SCOUGALL states that a commission from India visited California in 1885 and reported upon the results of their investigations there. The committee believed, and California authorities agreed with them, that the cropping up of alkali is caused "by the rise of the water table by sidewise soakage from the high-lying canals," and that the trouble had been "greatly aggravated by the lavish expenditure, amounting to a wicked waste, of canal water by the agriculturalist."

Regarding the character of alkaline soils Mr. SCOUGALL speaks as follows:

> Alkaline soils contain a large amount of highly soluble mineral salts, the result of the decomposition by air and water of the particles of rock minerals to be found in almost every soil between the surface and the subsoil water table; but it is the carbonate of sodium we have to deal with as the chief enemy of the productiveness of the soil. . . . Common salt, glaubers salt, sulphate of potassium, &c., are easily got rid of, and are only injurious when present in large quantities.

Mr. SCOUGALL states that he has never heard a word spoken regarding the suitability of the waters in Utah for irrigation, and thinks that it should at once be investigated, especially as it has been found that some California waters distributed so much alkali that their use was necessarily abandoned, notably the waters from Tulore and Kern Lakes.

To prevent the appearance of alkali, where there is danger from it, water should be sparingly used and drains 18 to 36 ins. below the surface should be provided to remove the water. Indeed these drains should be provided in any case. Where troublesome salts already exist, or are rapidly developing, how are they to be removed? First their exact nature should be determined by chemical analysis. There are, however, several crude tests for the presence of carbonate of sodium. Water standing in low alkali spots has a darkish brown tint, and will turn paper dyed yellow with tumeric to a brown tint or red litmus paper blue. Carbonate of sodium may be detected by adding the water suspected to contain it to gypsum water, when, if the carbonate is present, the gypsum water becomes turbid, and gypsum may be applied to the land as an antidote.

In some cases lime well harrowed into the land before irrigation begins will be efficacious; the only antidote, unless it be that mentioned below, for alkaline carbonates and borates, it is stated, is gypsum.

Alkaline or saline lands are reclaimed in Egypt and India by merely washing their surface and drawing off the water before it can soak in. It has been found that the washing is most successful in the winter months, when the water is clear, and being cold is less likely to sink into the soil.

For three or four years a company has been at work near Alexandria, Egypt, reclaiming the land beneath Lake Aboukir. The lake is said to cover an area of 35,000 acres, and the water is being removed by means of centrifugal pumps. A fresh water canal has been constructed around the lake, from which the land from which the water has been removed is washed. Small dams have been used to retain the fresh water on the newly exposed surface for several days, and it has been found that fresh water will take up 3.5% of salt and become the same specific gravity as sea water. Several thousand acres have been reclaimed by the company, sold, and are now under cultivation.

In India, "reh," as alkali is called, has been prevalent for centuries, and legislative and government relief has been instituted. In 1760 "reh" existed all along the West Jumna canal in the northwest provinces. From 1800 to 1830 the canal was abandoned and "reh" disappeared. In 1838 the canal was reopened, and soon after trouble was again experienced. Since 1838 the Indian Government has constructed several hundred miles of deep drains and limited the amount of water used in irrigation. In addition, the native must now, at least in some instances, pump water from the canals, instead of drawing it from headgates as formerly. This, of course, reduces waste.

It has been found that time, rather than large initial expenditures of money, is the most important element in removing salts by washing. Whether or not there is danger of developing alkali in a given piece of land, it is certain that there is in most, if not all, of our irrigated sections a great waste of water, which, in the interest of the vast unirrigated tracts, as well as for the sake of economy in the construction of irrigation works, should be saved. The necessity for drainage will also force itself upon our irrigationists in the course of time, for health will demand some rapid means of removing the waters from the subsoil. In some sections, of course, nature provides for this, but not in all.

Engineering Education in the British Dominions.

The Institution of Civil Engineers has just issued a pamphlet report on the above subject, which we regret to find gives wonderfully little accurate information, but which at least does give an accurate list of all the colleges and schools in the British Empire professing to give instruction in engineering. For several of these it does not even give the place where the school is located, for most of them it does not give the exact date when engineering classes were first formed or graduated, for no one of them does it give the number of students or graduates, and for only one or two does it give the cost of tuition or the number of professors and instructors in the engineering courses. For no single college in the list are given the name and title of the officer who should be addressed for further information, while the information given as to the courses of study is in most cases of a very vague and general nature. For no single college are the requirements for admission definitely stated.

It is, therefore, of little use to attempt to summarize with much fullness or care the contents of what might have been, and should have been, a very useful and interesting pamphlet; but a few facts which are deducible from the report are the following:

There are in and about London 6 engineering schools beside the Royal Naval College. Of these, one, the Royal College of Science, has only a school of mines consolidated with it, and its courses do not seem to be of determinate length, but to consist only of lectures and examinations. The Royal Indian Engineering College was formerly devoted exclusively to educating men for the Indian civil service, but is so no longer. The remaining four institutions are all branches of general universities, 2 having a 3-year course and 2 a 2-year course.

There are 14 provincial English schools enumerated, of which 2, attached to the Oxford and Cambridge, are as yet in a rather inchoate condition, and mainly devoted to giving some knowledge of the physical sciences to non-engineering students. These institutions are all, with one exception, in the north of England, and the education of artisans seems to be a large part of the work cut out for most of them, while none of them (so far as we can judge from the vague descriptions given) have courses fairly comparable in breadth and thoroughness with those of a dozen or more of our best scientific schools. Two of these provincial schools are just organized, 1 has a 2-year course, and the remainder have a 3-year course. In fact, with the exception of 2 colleges in Canada and 1 in Australia, there are no engineering schools in the British Empire with a longer than 3-year course.

There is one young but promising school in Wales, and 5 in Scotland, of which 2, the University of Glasgow (with which the great Prof. RANKINE was connected) and the Heriot Watt College, have 2-year courses, and the rest 3-year.

There are also 5 schools in Ireland which purport to have engineering courses, all 3-year, but so far as the vague descriptions can indicate the total amount of engineering instruction given is not very great, either in quantity or quality.

In India there are 3 engineering schools, chiefly devoted to educating native engineering assistants.

In Canada there are 3 engineering schools given, the University of Toronto with a 3-year course, McGill College, Montreal, 4-year course, and the "University of Kings College," Windsor, Nova Scotia, founded in 1789, to which a school of engineering was added in 1871. The first two institutions mentioned we know to give very good and thorough instruction. We have no accurate knowledge as to the last-named.

In Australia there are engineering schools connected with the University of Sydney, University of Melbourne (4 year course), Adelaide University and University of New Zealand, the last not yet opened.

This makes a total of 31 institutions in the British Empire, good, bad and indifferent, which purport to give instruction in civil engineering, of which 21 are in the colonies. In the United States there are now upward of 100, the average strength of which, in numbers and thoroughness of instruction, we judge to be considerably in advance of the British average, if such a guess may be hazarded on such confessedly imperfect information. It is certain, however, that there is no single engineering school in Great Britain which can compare in number of yearly graduates with a dozen or so of our leading schools, while our impression is that the course of study in these latter schools is more thorough and more severe than in any of the British schools, with two or three possible exceptions. We may add that we have recently collected, and have now in course of digest, very complete and elaborate details in regard to the past and present status of all our own technical schools, on which the opinions above expressed are in part based, and which we trust will be found at least to give more interesting, complete and satisfactory information as to the present status of engineering education here than what we have been able to deduce herein from this remarkably imperfect report on British schools.

The Technical Courses in the Leland Stanford Junior University.

The following description of the courses of technical instruction planned for the new Leland Stanford Junior University at Palo Alto, Cal., has been prepared at our request by CHAS. D. MARX, Professor of Civil Engineering in that institution. We are assured from authoritative sources that the facilities for technical instruction which are planned there are to exceed anything yet created at any technical school in the country. We believe that this and Lehigh University are the only technical schools in the country where tuition is absolutely free:

On Oct. 1, 1891, the Leland Stanford Junior University at Palo Alto was officially opened. The daily press has taken due notice of the fact, and general information has been spread broadcast over the land. Magnificent buildings and millions of endowment are said to be the property of the university; unequaled facilities for the pursuit of any and every study are reported to exist. The former statement is true, the latter we hope will be in the course of time. It is, therefore, not the description of a completed structure that I can bring before your readers. The foundations have been laid, and the fact that they have been laid deep and strong on the basis of modern scientific scholarship is the special justification for the appearance of this article in the columns of ENGINEERING NEWS. The Leland Stanford Junior University is to be a university in the broadest sense of the term; and in speaking of the present condition and prospective development of her technical courses I am, of course, but dealing with the foundations and plans of one wing of the structure.

In the October number of the *Educational Review*, President WALKER concludes an article on "Schools of Technology" with these words: "Possibly some ultimate form for institutions of higher learning may yet be developed which shall embody much of both the modern school of technology and the old fashioned college, with perhaps something taken from neither, but originating in the larger, fuller and riper life of a happier and a richer future." The aims of the technical schools of Stanford University lie in this direction.

At most institutions in America the entrance requirements to the techical courses are lower than they are for the so-called cultural courses in Arts, Letters, History or Philosophy. A line of division is drawn at entrance which no amount of subsequent work on the part of the technical student can erase. The latter may do twice the amount of work that his fellow student in the literary course does, work that develops his best qualities and more than makes up for discrepancy in entrance requirements, but all to no avail. He stands as a representative of a lower education. One little clause in the entrance requirements of Stanford University must, therefore, be hailed with joy by all the members of the engineering profession. "The same entrance examination will admit the student to all the courses in the university alike." That the requirements are in excess of what an engineering student should bring no one is likely to claim. Let me state them briefly: (1) English, with special stress upon composition; (2) Arithmetic; (3) Algebra through Quadratics; (4) Plane Geometry; (5) Geography; (6) History of the United States; (7) Latin, or French or German, one year; (8) Elementary Physics. (Scientific requirements, any two of the following to be passed before the beginning of the second year); (9) Mathematics, including advanced algebra, solid geometry and plane trigonometry; (10) Freehand drawing; (11) Chemistry; (12) Physiology; (13) Zoology; (14) Botany. (Language and Literature, any two of the following to be passed before the beginning of the second year); (15) Latin, including two additional orations of Cicero, six books of Virgil and Roman history; (16) Greek, including book I. of Xenophon's Anabasis, two books of Homer, Greek prose composition and Greek history; (17) French; (18) German; (19) English Literature; (20) History. The completion of the four years' course in applied sciences, engineering, etc., leads to the degree of B. S., and an additional year of satisfactory graduate work accompanied by a satisfactory thesis, to the degree of M. E. or C. E., as the case may be.

The work in the university is largely elective; and this holds true also to a limited extent for the technical courses. The necessity of a thorough mathematical training for the advanced work restricts the students in engineering somewhat in the choice of electives during the first two years of their course. At the end of that time a student can begin to specialize, should he desire to do so, though in the interest of a broad, general and professional training most of the men will be advised to postpone the choice of a specialty until their fifth year. Technical students will be especially encouraged to take electives along the line of history, political economy, literature and modern languages.

So far only two departments of engineering have been established, mechanical and civil. The large number of students which crowded into these technical courses at the opening of the university will undoubtedly tend in the near future to the establishment of courses in electrical and mining engineering and in architecture. As no estimate could be made of the number of students to be expected, and as the work of the university was supposed to begin with the freshman class, but one chair was established in each of the departments above mentioned. In addition an instructor in shop work was appointed. A short time, however, before the opening of the term it became apparent that more students would appear than had been expected, not a few upper classmen among the number, and that additional instructing force had to be provided. An assistant professor in mechanical engineering was added, as also an instructor in freehand drawing and an assistant in mechanical drawing. These six men, then, constitute the present force, for giving professional instruction in engineering subjects pure and simple. A chair of applied mechanics has just been created and will be filled before the beginning of next year. Of course the list of appointments as given does not include the members of the department of pure mathematics.

At present there are about 120 students in the technical courses of the university, distributed as follows:

	Freshmen.	Sophomores.	Juniors.	Seniors.
Mechanical engineering	25	4	2	1
Electrical "	9	..	..	..
Civil "	34	4	3	1
Mining "	2	..	..	..
Architecture	1	..	..	..

The rest are special students in mechanical and civil engineering, that is, men of mature age and practical experience who desire to add to their practical the theoretic knowledge of their profession.

The course in mechanical engineering as laid out by Prof. H. B. GALE is a thorough one. The required studies of the first year include advanced algebra, solid geometry, trigonometry, descriptive geometry, plane analytic geometry, English composition, mechanical and freehand drawing, and shop work. These are followed in the second year by calculus, mechanics, physics, kinematics and steam engineering, with drawing, laboratory and shop work. In the third year mechanics is continued and dynamics of machinery is taken up. Drawing and laboratory work are also continued. During this year technical options are offered in, (1) stationary steam engineering; (2) electrical engineering; (3) mill engineering and construction; (4) marine engineering; (5) railway engineering; (6) hydraulics and hydraulic motors. The fourth year studies are entirely elective. A chair of machine design has just been established, and additional professorships for giving this varied and complete course will be created as the students are brought up from the lower classes prepared to take it, or as students may enter from elsewhere to advanced standing.

What has been stated for the course in mechanical engineering holds true of that in civil engineering. The work of the first year is identical with that of the mechanical engineering course, so that students may postpone the decision as to their special main line of work as long as possible. The mathematics of the second year are the same as in the course in mechanical engineering. Characteristic studies of the Sophomore year in civil engineering are land and railroad surveying, with considerable field work. As soon as the needs of the department warrant it, chairs in geodetic and railroad engineering will be created to handle these subjects. Strength of materials with corresponding laboratory work, masonry construction and foundations, engineering architecture, analytic and graphical computations of stresses in framed structures, the designing of roofs and bridges, take up most of the time of the student during the Junior year. Bridge engineering, too, is to be developed later as one of the special courses in the department. The study of the mechanics of fluids in connection with considerable laboratory work in hydraulics is followed in the Senior year with a course in water-supply engineering, sewerage, roads, streets and pavements. A professorship of municipal engineering will be created for this work. The needs of the Pacific coast demand that special attention be given

to irrigation, and suitable provision will also be made for what might be called "agricultural" engineering. While it is the intention to give instruction in the methods of improving rivers and harbors, and to study what is being done in this country and abroad, it is hardly time for advising young men to take up as a specialty this line of work. It rests with Congress to hasten or delay this time.

This, then, is a brief synopsis of the work which the technical courses in the Leland Stanford Junior University will attempt to do. In planning, the aim has been to bring them abreast of all that is best in modern technological education. We recognize the fact that as President HALL, of Clark University, says: "The exaltation or degradation of the pulpit, the bar, and of the medical sciences, and now of increasing industrial processes, and even international competitions, great projects and government works, &c., depend upon the efficiency of universities as never before." To send out engineers, educated in all that term implies, to bear their part in solving the problems that fall to their lot, is the aim of the technical departments of the Leland Stanford Junior University.

A Three-Cylinder Electric Pump.

The Gould's Manufacturing Co., of Seneca Falls, N. Y., has for some time made a specialty of three cylinder or "Triplex" power pumps, driven by cranks spaced on a common shaft at angles of 120°. The triplex pump is especially suited for use with an electric motor as the driving mechanism, on account of the small variation in the resistance offered by the pump pistons at different points in the revolution; and a considerable variety of electric triplex pumps are now made by the company. We illustrate herewith a large size electric triplex pump which is to be placed in the new building of the Oregonian Publishing Co., at Portland, Ore. Fig. 1 is a rear view of the pump, reproduced from a photograph, showing the air and valve chambers and the suction and delivery pipes. Fig. 2 is an end elevation showing the pulley and spur wheels by which the pump is driven from the motor.

TEST OF GOULD'S TRIPLEX PUMP, 10 × 12 IN. CYLINDERS, DRIVEN BY BELT FROM 120-500 THOMSON-HOUSTON MOTOR.

Pressure, Lbs. per sq. in.	Head,* Ft.	E. M. F. Volts.	Current. Amperes.	Electrical HP.	Revs. per min. of pump.	Mean HP. delivered to pump.	Efficiency. P. c. of combination.	Mean HP. delivered by pump.	Mean HP. absorbed by pump.	Efficiency. P. c. of pump.	Actual delivery. Galls. per min.	Pump slip. P. c.
175	408.	502	69.5	46.8	26.	39.1	69.6	32.6	6.5	83.5	316.7	.41
150	351.	473	63.	39.9	24.7	32 3	66.7	26.6	5.7	82.2	300.5	.33
125	291.5	475	54.5	34.7	25.2	28.5	64.5	22.4	6.1	78.5	304.1	1.3
100	234.	526	45.7	32.3	26.7	25.3	59.7	19.3	6.0	76.4	326.8	.09
75	176.	526	37.5	26.4	27.2	19 7	55.7	14.7	5.0	74.6	330.3	.82
50	118.5	527	30.	21 2	27.2	14.6	46.9	9.94	4.7	68.	331 8	.36
25	60.7	531	22.5	16.	27.8	9.60	32.3	5.20	4.4	54.2	338.8	.35
0	....	470	12.8	8.05	27.4	2.21	....	....	2.2	....	.....	.....

* Suction, 3 ft.
Motor and countershaft require 5.62 electrical HP.
Motor alone requires 4.78 electrical HP.
Fields require 1.15 electrical HP.

The triplex pump is especially suited for use with an electric motor as the driving mechanism, on account of the small variation in the resistance offered by the pump pistons at different points in the revolution; and a considerable variety of electric triplex pumps are now made by the company. We illustrate herewith a large size electric triplex pump which is to be placed in the new building of the Oregonian Publishing Co., at Portland, Ore. Fig. 1 is a rear view of the pump, reproduced from a photograph, showing the air and valve chambers and the suction and delivery pipes. Fig. 2 is an end elevation showing the pulley and spur wheels by which the pump is driven from the motor.

The main frame of the machine is a single casting containing the three vertical cylinders in the base and having the supporting columns for the crank and counter shafts. The crank shaft is of steel, and turns in babbitted boxes. The large gear wheels by which it is driven are 50 ins. diameter on the pitch line, and the small spur gears which engage with them are 9 ins. diameter. The driving pulley on the counter shaft is 32 ins. diameter. The pump stands 8 ft. 7 ins. high and occupies a floor space of 6 ft. × 7½ ft. The pump plungers are 10 ins. in diameter and 12 ins. stroke. The terms of sale guarantee this pump to deliver 500 galls. per minute into a pressure tank against 90 lbs. pressure per sq. in. The pump will run at a speed of 42 revolutions per minute and will be driven by a belt from a 40-HP. Edison electric motor.

The company informs us that with this pump a controlling device will be supplied by which a uniform pressure of 90 lbs. will be maintained in the tank, and the motor and pump will be kept running continuously, yet without load, except when necessary to maintain the pressure. Just how constant or varying the service is we do not know; but unless there is a fairly steady demand upon the pump, this arrangement would seem to be rather wasteful of power. The friction of the pump and gears must be very considerable; and if the pump is kept running all the time at normal speed, a good deal of power must be absorbed merely in overcoming its friction.

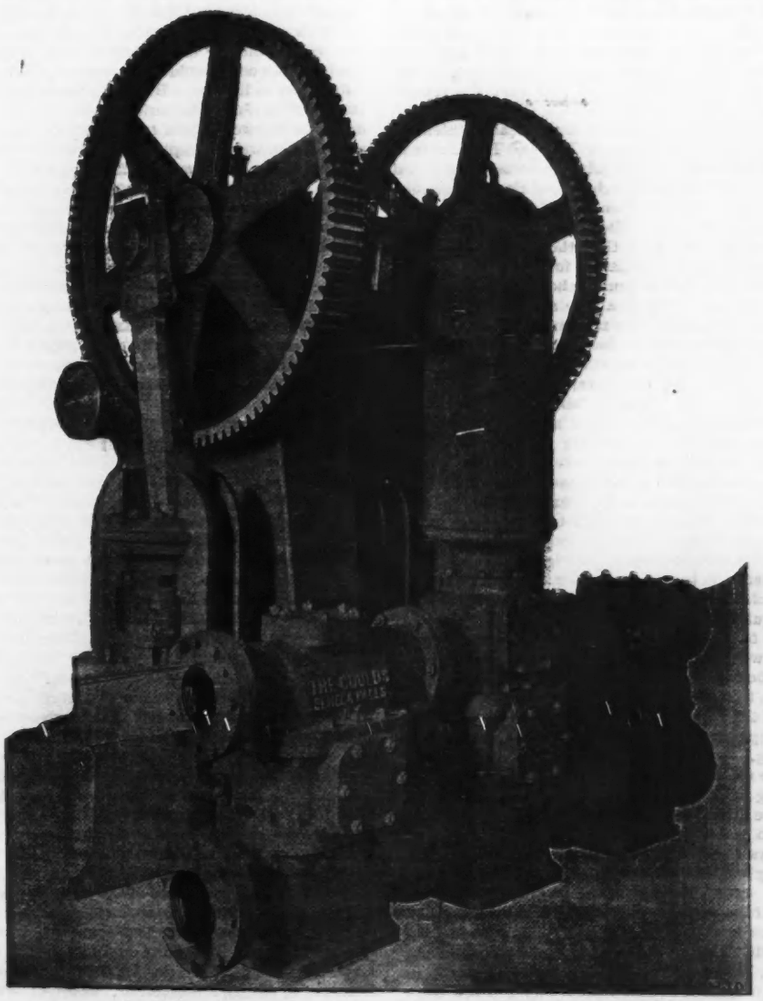

FIG. 1. THREE-CYLINDER PUMP. Built by the Gould's M'f'g Co.

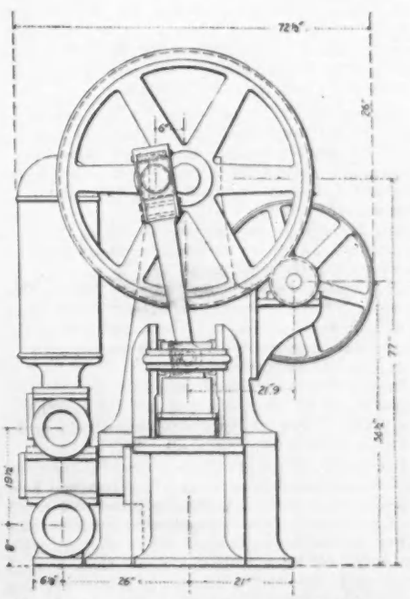

Fig. 2. End Elevation of Three Cylinder Pump.

The cylinders are single acting, and their plungers are outside packed with a gland, so that any leakage is at once perceptible and may be easily remedied.

It is claimed that this type of pump will work more smoothly and evenly than a two-cylinder double-acting crank pump; and the outside packed plungers are more easily kept tight and in good order than double-acting pistons.

In reply to this criticism the manufacturers send us the accompanying table showing the friction and the efficiency of the pump at different speeds, and say:

In regard to regulating device, it sometimes occurs that they wish to run the motor continuously and do other work besides running the pump. In this case, of course, the pump runs continuously, too. If desired, however, the pump can be automatically started and stopped with variation of tank pressure from predetermined point.

We agree with you that where elevators are not run continuously there is some power lost in running the pump all the time; but where the elevators are run continuously, economy is on the side of running the pump continuously.

The Comparative Merits of Various Systems of Car Lighting.

XII.

ELECTRIC LIGHTING.

It is safe to say that there has been more work done on the designing and perfecting of electric car lighting systems than on all other systems of car lighting combined. The most progressive railways in America, Great Britain, France, Germany and Belgium have assisted and encouraged the inventors who during the past five years have wrestled with the problem of designing a commercially successful electric lighting system for railway trains. In fact there are few innovations in railway practice which have met with such general favor as the introduction of the electric light for use on trains; and the experiments have been in many cases persistently kept up at a large outlay for a considerable time.

There are many reasons for this popular favor of electric car lighting. Its admitted great advantages in cleanliness, safety, and freedom from heat and odors, the great success of stationary electric lighting, the popular interest in electrical progress, are among the chief reasons. Besides this the electric light is generally considered a luxury; and for the fitting up of the fast express trains which are a prominent feature of modern railroading, luxuries of every sort are in demand.

The great difficulty in lighting trains by electricity is in furnishing the electric current to the lamps at all times and places where it is needed, not only when the train is running, but when it is standing still, when the locomotive is detached, and even when the cars are separated from each other, as in the case of sleeping cars which stand at a station for the entry of passengers for hours, perhaps, before starting on their journey. These difficulties have been met in various ways; and the methods employed for overcoming them constitute the chief point of interest in the various methods of electric car lighting which have been proposed or tried. We may classify these methods as follows:

I. *Primary battery system.*—In which the current is furnished from some form of primary battery.

II. *Storage battery system.*—In which the current is furnished entirely by storage batteries which are charged with electricity from stationary plants at the ends of the trip.

III. *Direct dynamo system.*—In which the electricity is furnished from a dynamo at some point on the train directly to the lamps.

IV. *Combined dynamo and storage battery system.*—In which the storage batteries are charged by a dynamo on the train, and the current from the dynamo is supplemented by that from the storage batteries, or vice versa.

V. *Track wire system.*—In which an electric wire is run along the line of the road and the current is taken from it by a trolley or shoe on the train or on each car of the train.

In order to discuss intelligently the relative merits of these systems it is necessary to understand how much light is likely to be required and how much electrical energy will be required to furnish this light. An ordinary passenger car is well lit with 160 c. p. of light, although more than this is required if brilliant illumination is desired, and considerably more is necessary to satisfactorily light sleeping and parlor cars. European standards of good practice in car lighting are much lower than ours, as was shown in our article on oil lamps. For this reason experiments in electric car lighting have been more readily made there, and have been considered successful; whereas the same experiments, if made here, would have been considered a failure on account of the insufficiency of the light furnished. This fact is to be borne in mind in considering the reports of European experience with some of the systems of electric lighting which have not found favor here.

Taking 160 candle power per car as the amount of light necessary, experience shows that a fairly efficient plant of lamps and wires ought to furnish this from 1 HP. of electrical energy. An 8-car train will therefore require 8 HP.; and remembering that on the express trains, for which electric lighting is chiefly used, several of the cars will be parlor or sleeping cars requiring 40 or 50 more candle power of light, also that the loss in converting chemical or mechanical energy into electrical energy must be provided for, we see that the steam engines of 12 to 15 HP. commonly used for train lighting are none too large for their work.

Taking up now the primary battery system, it is plain that even if no more than 5 electrical HP. are necessary for lighting a train, under existing conditions the primary battery cannot possibly compete with other methods of generating the current. To produce an electric current from a primary battery, zinc or some other metal is burned in an acid bath, and the quantity of zinc and chemicals which it would be necessary to use up in order to produce 5 HP. of electrical energy makes the primary battery out of the question for this as for other places where large amounts of power are required. This question was well handled by Mr. GEO. GIBBS in his paper before the Western Railway Club last spring (see ENG. NEWS, March 7, 1891) in which he stated that the cost of electrical energy from primary batteries was at least 40 times as great as the cost of the same energy from a steam engine and dynamo. Nevertheless, so great is the faith of inventors in their pet hobbies and of the public in the possibilities of electricity, that this system has been repeatedly tried abroad. One train is said to have run for nearly a year between Paris and Brussells lit by electricity from bichromate batteries; and experiments have also been made in England. So far as we can learn no trial of the system has ever been made in this country. It was reported in 1887 that the scheme was to be tried on the New York Central & Hudson River R. R., and within a few weeks a statement that the New York & New England R. R. was to equip one car with the primary battery developed by the Safety Electric Light Co., of Boston, has been published. A letter from Mr. C. A. COTTON, Electrician of the Safety Electric Light Co., does not confirm this, but says that they "have been very successful, and are preparing for active business."

Of the fifth system named above, furnishing electricity to the train from a wire along the track, it is evident enough that it is not generally applicable to railway service. On a line where trains run very closely and where the same trains are kept running all the time, as, for instance, on elevated railways, there seems reason to believe that this would be an effective and economical method of lighting. Cars on electric railways are generally lit by this system, the current being taken from the trolley wire. On one railway in England and one Russian railway this system is in operation for lighting trains while passing through tunnels. This is, of course, practically applicable only where comparatively few cars are to pass through the tunnel, and to Americans it seems a very roundabout method of reaching a simple end. Instead of wiring and and equipping with lamps a hundred or more cars, merely to light them while passing through a tunnel, it would seem manifestly cheaper and better to light the tunnel, arranging automatic devices, if desirable, to turn on the current only during the passage of the train, or perhaps in long tunnels using the lamps only in that section in which the train is running.

There remain, then, three systems of electric train lighting for consideration: the storage battery system, the direct dynamo system and the combined dynamo and storage battery system; and it is by these systems that practically all the electric train lighting has thus far been done.

THE STORAGE BATTERY SYSTEM.

One of the earliest applications of the storage battery after it was perfected to the point of commercial availability was to the lighting of railway trains. In August, 1882, some Faure accumulators brought to this country from France were tried for a few days in passenger coach No. 397 of the Pennsylvania R. R.; and so far as we can learn, this was the first instance of railway car lighting by electricity in this country. It was also among the first instances of the electric lighting of a railway car in the world. Experiments were made somewhat earlier in the same year on the Paris, Lyons & Mediterranean Ry. in France, where a train was lit by ten 20 c. p. Swan incandescent lamps (about enough to light fairly well one American sleeping car) furnished with current by a Gramme dynamo, driven by a belt from a pulley on the car axle.

The first instance of the electric lighting of a railway car of which we have been able to find any record was on the London, Brighton & South Coast Ry. in England. In October, 1881, a Pullman car on this road was fitted with storage batteries and employed in regular traffic between London and Brighton. The batteries were charged during the night at London by a special engine and dynamo. The system was soon extended to the lighting of whole trains; but the inconveniences of charging the batteries at the station led to the modification of the system by the addition of a dynamo driven from the car axle.

The results of the Pennsylvania Railroad's first experiments encouraged the belief that when the storage battery was somewhat improved it could be successfully used for electric car lighting. In the summer of 1884, experiments were made at Altoona under Dr. DUDLEY'S direction with the Brush storage battery; and their success was such that eight parlor cars were equipped with incandescent lamps and put in service April 1, 1885. Batteries made by the Electrical Accumulator Co. were afterward substituted for the Brush batteries, and seven more parlor cars were fitted with the system in May, 1889. These cars we believe are still running.

In 1886 two companies, the Electrical Accumulator Co. and the Julien Electric Co., began actively to push the storage battery for use in car lighting; and as a result of their labors several railways in 1887 began the use of electric lighting from storage batteries on a considerable scale. The Boston & Albany began lighting a Boston suburban train with current from Julien batteries in January, 1887, and on March 29 two express trains between New York and Boston were completely equipped with the electric light. Each car had 22 lamps (16 c. p. each) and a 60-cell battery weighing about a ton. The batteries were charged without removing them from the cars, and as a consequence each train had to lie at either terminus for about 10 hours while the batteries were being charged. Notwithstanding this Mr. G. W. BLODGETT, electrical engineer of the Boston & Albany R. R., in a paper written soon after these trains began running, waxed enthusiastic over the system and said: "In the near future we may be reasonably certain that electric lamps in the cars will be as common as the air brake and Miller platform."

In the latter part of 1887 the Canada Atlantic Ry. equipped an express train with Julien batteries, the first run being made Nov. 2, and the Intercolonial Ry. equipped two trains of 9 cars each with the same system. The Burlington, Cedar Rapids & Northern put two trains in service on March 10, 1888, equipped with Electrical Accumulator Co.'s cells. Another, and perhaps the most prominent experimenter was the Pullman Car Co., which equipped two of the New York & Chicago Limited trains over the Pennsylvania Railroad in 1887, one with Electrical Accumulator cells, and the other with Julien cells. Several other companies experimented with one or other of the systems to quite an extent. Thus the sum total of experience with the storage battery was sufficient to enable a fair opinion to be formed as to its merits or demerits for car lighting use.

It must be confessed that this experience has shown considerably more demerit than merit in the system. The excessive first cost, when the train is furnished with enough light for brilliant illumination, and the excessive cost of maintenance, owing chiefly to the short life of the storage batteries, even when handled with the greatest care, are two great obstacles to any general use of the system; but the greatest objection from an operating standpoint is the trouble of exchanging the spent batteries for the charged ones. It is quite out of the question to throw the car out of service for the length of time necessary to charge the batteries. It might be done for a few trains, and has been done by the Boston & Albany and some other roads; but that it could not be generally done with all the passenger trains of a railway is too plain to need proof. On the other hand, to remove a ton of spent batteries from each car at the end of each trip, and replace them by a ton of fresh batteries is a most serious burden, if any considerable number of cars are equipped. Placing the cars in convenient position, holding them there while the work is being done, handling the heavy batteries, and making the connections in proper shape—all these things mean expense and delay. There are, too, other annoyances in the use

of storage batteries of which we shall speak farther on. Those already named, however, furnish ample explanation for the fact that the storage battery system of lighting seems to have gone out of use as rapidly as it came in. The Boston & Albany abandoned it in the fall of 1889 after about two and one half year's trial; and we believe that some Intercolonial cars and some Pennsylvania parlor cars are the only ones in America now lit by storage batteries alone. The Khotinsky system, in use on the Fulda-Frankfort and Berlin-Frankfort lines, is the only instance we now recall abroad.

DIRECT DYNAMO SYSTEM.

In this system the use of storage batteries is entirely dispensed with and electricity is furnished to the whole train from a dynamo placed at some point by electricity from a dynamo placed on the tender on the train, and run by a small steam engine. As noted above, almost the first railway train ever lit by electricity, that run in 1882 on the Paris, Lyons & Mediterranean Ry. used this system and it has also been tried on a German railway, on the Metropolitan Ry. of London, on the Lancashire & Yorkshire Rv., and on the Great Eastern Ry. A train on the London & Northwestern Ry. began running Aug. 6, 1884, lit and driven by a small steam engine under control of the engine driver. This train is still running.

In this country the direct dynamo system was taken up by the Chicago, Milwaukee & St. Paul in 1889. A full account of the system as worked out on that road by Mr. GEO. GIBBS, to whose ingenuity most of its details are due, will be found in our issue of March 12, 1891, p. 235. Briefly, the engine and dynamo are placed in the end of the baggage car or in winter in a separate car designed especially for them, and are started running as soon as the train is made up. Each car is equipped with an auxiliary outfit of oil lamps, which is used to furnish light before the train is made up.

It will be noted that the chief danger of oil lighting (spilling the oil in case of accident) is retained with this system. This could be obviated by the use of candles for the auxiliary lighting apparatus in place of oil lamps, provided the electric system can be made sufficiently reliable to make the use of the auxiliary system while running necessary only in rare instances.

The Chicago, Milwaukee & St. Paul has 62 cars equipped for this system, and finds it much more satisfactory than the combined storage battery and dynamo system, which they tried for a year before adopting the direct system.

There is little doubt that this system is cheaper than any other electric lighting system. For through express trains, where the cars are kept together for long distances, it seems to be well suited. Whether for trains making runs of moderate length, dropping a car at this junction and picking up another at that, this system could be applied with practical success, may well be doubted. On such trains the auxiliary system would be in frequent use, and the cost of its maintenance, including breakage, cleaning, &c., would be little less than if the car were lit by the oil lamps all the time. Such an expense is hardly one that can be generally borne; and in addition the nuisance of having to light the oil lamps in the whole train every time it was desired to set off a car near the head would be sufficient to condemn it in the minds of most railway managers.

The Commingler System of Car Heating.

In our issue of Sept. 6, 1890, we described and illustrated the "Commingler" system of heating invented by Mr. JAS. F. MCELROY, Mechanical Superintendent of the Consolidated Car Heating Co. This system has since that time been put into use on the Canadian Pacific and quite a number of other prominent railways, and it has also found its way into use for stationary heating purposes, for which in cases where the circulation is especially difficult to maintain, it has proved to be admirably adapted.

The essential feature of the system is the "commingler," shown in Fig. 1 (which we reproduce from our issue above referred to). It consists of a pear shaped iron vessel filled with small quartz pebbles, which are held in place between perforated diaphragms. The steam is distributed through the mass of pebbles by a perforated pipe connected to the steam supply pipe, and the force of the issuing steam jets is such that a constant and rapid circulation is kept up in the heating coils. The heavy pounding and noise when steam is allowed to escape directly into water below the boiling point is well known. The commingler distributes the steam in such fine jets that its condensation is noiseless and there is no vibration or ringing of the pipes. Its capacity for maintaining a circulation is shown by its performance in heating the Whitehall tunnel of the Delaware & Hudson Canal Co.'s R. R., where one commingler keeps the tunnel ditches free from ice in the coldest weather, circulating water through over 2,000 ft. of pipe. The car house of the Albany Electric Ry. is also heated by the commingler system.

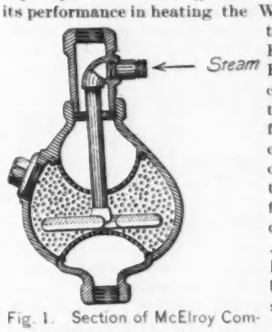

Fig. 1. Section of McElroy Commingler for Steam Heating.

While the commingler alone with the necessary cocks, radiating pipes, &c., is all the apparatus essential for heating a car, it is desirable, in some cases, that a means of independent heating be retained, to permit the heating of the car while standing at stations or when on roads not using steam heat. Fig. 2 shows the combination of the commingler system with an independent heater, and also the expansion drum and overflow connections. It is pointed out that in the ordinary hot water circulating system, any small leak may pass unnoticed and the expansion drum overhead will gradually be emptied of water, when of course no further circulation can take place. Again in a closed hot water system, in which water is pumped into the pipes, the air in the pipes collects in the expansion drum and is gradually compressed, sometimes causing considerable pressure in the pipes. The fact that water is all the time being contributed to the circulation in the commingler system by the condensation of the steam in the pipes does away with the first difficulty, while the connection of the open overflow pipe to the expansion drum does away with the second.

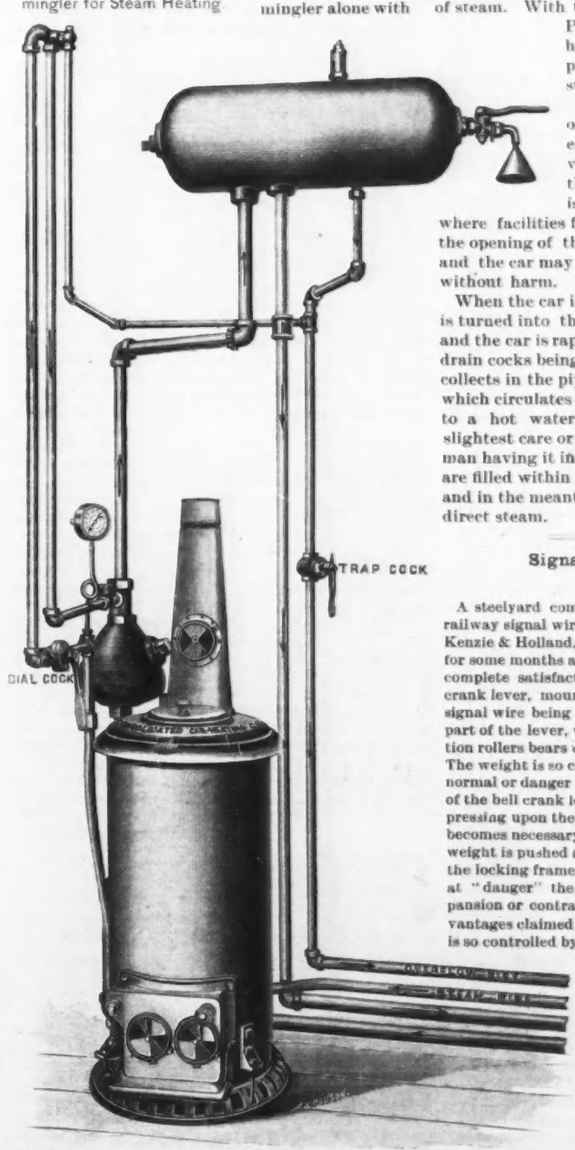

Fig. 2. Combination of Commingler System with Independent Heater.

The manufacturers claim that this system will heat a train with less pressure in the train pipe than any other hot water heating system, which is important in increasing the life of the hose connections and decreasing leakage. Experiments conducted last year under the supervision of the New York Central & Hudson River R. R. showed that circulation was rapidly established by the commingler with 1¾ lbs. of steam. With the vacuum return system of the Pennsylvania R. R., the commingler has worked with a difference in pressure of only 2 lbs. between the supply and return pipes.

Probably the greatest advantage of the commingler system, however, is that it combines the advantages of the direct steam and the hot water systems. When a car is out of service on a side track where facilities for furnishing steam may not exist, the opening of the drain cock empties all the pipes, and the car may be exposed to the coldest weather without harm.

When the car is again brought into service steam is turned into the pipes through the commingler and the car is rapidly heated with direct steam. The drain cocks being closed, the water of condensation collects in the pipes until they are filled with water which circulates automatically. It is thus changed to a hot water circulating system without the slightest care or attention on the part of the trainman having it in charge. In cold weather the pipes are filled within two hours after steam is turned on and in the meantime the car has been heated with direct steam.

Signal Wire Compensator.

A steelyard compensator for automatically adjusting railway signal wires has been patented by Messrs. McKenzie & Holland, of Worcester, and has now been in use for some months at the Worcester railway station, giving complete satisfaction. The apparatus consists of a bell crank lever, mounted in a suitable cast-iron frame, the signal wire being attached to the shortest and vertical part of the lever, while a sliding weight fitted with friction rollers bears upon the horizontal part of the lever. The weight is so constructed that when the signal is in its normal or danger position, part of it overhangs the center of the bell crank lever; sufficient weight is, however, left pressing upon the lever to keep the wire taut. When it becomes necessary to lower the signal to "all right," the weight is pushed along the lever by means of the lever in the locking frame, and when the signal is at "all right" or at "danger" the weight is free to counteract either expansion or contraction of the signal wire. The chief advantages claimed for the apparatus are: The signal arm is so controlled by the apparatus that it must indicate either "danger" or "all right." It cannot show partly on and off. The apparatus will compensate the wire at any distance or temperature, either when the signal is showing "all right" or "danger." No back or tail weight is required to assist the signalman in pulling the signal off to "all right," the distant signals being worked with the same ease as the home and starting signals. When working the distant signal all jerking and snatching is avoided, a steady pull being all that is necessary to put the signal to "all right;" consequently there is little liability of the wire breaking; should, however, the wire break the signal would instantly go to "danger." The apparatus can be fixed either inside or outside the signalman's cabin. The present adjusting gear can be dispensed with.—*The Engineer* (London).

Modern Methods of Quarrying.

Mr. WM. L. SAUNDERS, for many years the engineer of the Ingersoll Rock Drill Co., and hence thoroughly familiar with modern quarrying practice, read a paper before the last meeting of the American Society of Civil Engineers on the above subject, containing many interesting points, which we abstract as follows.

As a preliminary to describing the new Knox system of quarrying, which even yet is not universally known among quarrymen, Mr. SAUNDERS gives the following in regard to older methods:

The Knox system is a recent invention; no mention was made of it in the tenth census, and no description has yet been given of it in any publications on quarrying. The first work done by this method was in 1885, and at the close of that year 2 quarries had adopted it. In 1886 it was used in 20 quarries; in 1887 in 44, in 1888 in upward of 100, and at the present time about 300 quarries have adopted it. Its purpose is to release dimension stone from its place in the bed, by so directing an explosive force that it is made to cleave the rock in a prescribed line without injury. The system is also used for breaking up detached blocks of stone into smaller sizes.

Quarrymen have, ever since the introduction of blasting, tried to direct the blast so as to save stock. Holes drilled by hand are seldom round. The shape of the bit and the irregular rotation while drilling usually produce a hole of somewhat triangular section. It was observed, many years ago, that when a blast was fired in a hand-drilled hole the rock usually broke in three directions, radiating from the points of the triangle in the hole. This led quarrymen to look for a means by which the hole might be shaped in accordance with a prescribed direction of cleavage.

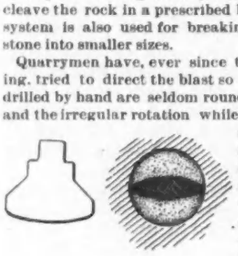

Fig. 1.

The oldest sandstone quarries in America are those at Portland, Conn. It was from these quarries that great quantities of brownstone were shipped for buildings in New York. The typical "brownstone front" is all built of Portland stone. As the Portland quarries were carried to great depths the thickness of bed increased, as it usually does in quarries. With beds from 10 to 20 ft. deep, all of solid and valuable brownstone, it became a matter of importance that some device should be applied which would shear the stone from its bed without loss of stock and without the necessity of making artificial beds at short distances. A system was adopted and used successfully for a number of years which comprised the drilling of deep holes from 10 to 12 ins. in diameter, and charging them with explosives placed in a canister of peculiar shape. The drilling of this hole is so interesting as to warrant a passing notice. The system was similar to that followed with the old-fashioned drop drill. The weight of the bit was the force which struck the blow, and this bit was simply raised or lowered by a crank turned by two men at the wheel. The bit resembled a broad axe in shape, in that it was extremely broad, tapering to a sharp point and convex along the edge.

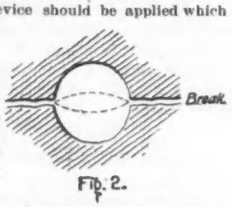

Fig. 2.

Fig. 1 illustrates in section one of the Portland drills and a drill hole with the canister containing the explosive in place. The canister was made of two curved pieces of sheet tin with soldered edges, cloth or paper being used at the ends. It was surrounded with sand or earth, so that the effect of the blast was practically the same as though the hole were drilled in the shape of the canister. In other words, the old Portland system was to drill a large, round hole, put in a canister, and then fill up a good part of the hole. Were it possible to drill the hole in the shape of the canister it would obviously save a good deal of work which had to be undone. The Portland system was, therefore, an extravagant one, but the results accomplished were such as to fully warrant its use. Straight and true breaks were made, following the line of the longer axis of the canister section, as in Fig. 2.

It was found that with the old Portland canister two breaks might be made at right angles by a single blast, when using a canister shaped like a square prism. In some of the large blasts, where blocks weighing in the neighborhood of 2,000 tons were sheared on the bed, two holes as deep as 20 ft. were drilled close together. The core between the holes was then chipped out and large canisters measuring 2 ft. across from edge to edge were used.

In regard to another of the older systems of blasting, known as Lewising, Mr. SAUNDERS says:

A Lewis hole is made by drilling two or three holes close together and parallel with each other, the partitions between the holes being broken down by using what is known as a broach. Thus a wide hole or groove is formed in which powder is inserted, either by ramming it directly in the hole, or by putting it in a canister, shaped somewhat like the Lewis hole trench. A complex Lewis hole is the combination of 3 drill holes, while a compound Lewis hole contains 4 holes. Lewising is confined almost entirely to granite. In some cases a series of Lewis holes is put in along the bench at distances of 10 and 25 ft. apart, or even greater, each Lewis hole being situated equi-distant from the face of the bench. The holes are blasted simultaneously by the electric battery.

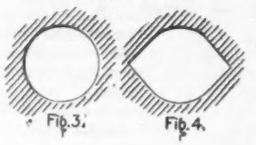

Fig. 3. Fig. 4. Fig. 5.

After noting another system used to a limited extent, and not to be commended, viz., the use of inverted plugs and feathers (the plugs and feathers being inserted as a sort of tamping, which the blast drives upward to split the rock), Mr. SAUNDERS continues in substance as follows:

It is thus seen that the "state of the art" has been progressive, though it was imperfect. Mr. SPERR, in his

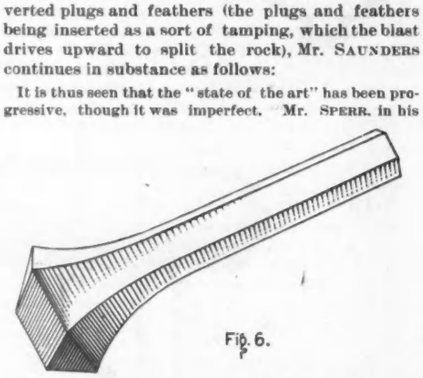

Fig. 6.

reference to this subject, made in the report of the tenth census, says: "The influence of the shape of the drill hole upon the effects of the blast does not seem to be generally known, and a great waste of material necessarily follows." This was written but a few years before the introduction of the new system, and it is doubtless true that attention was thus widely directed to the conspicuous waste, due to a lack of knowledge of the influence of the shape of a drill hole on the effect of a blast. The system developed by Mr. KNOX practically does all and more than was done by the old Portland system, and it does it at far less expense. It can best be described by illustrations.

Fig. 7.

Fig. 3 is a round hole drilled either by hand or otherwise, preferably otherwise, because an important point is to get it round. Fig. 4 is the improved form of hole, and this is made by inserting a reamer, Figs. 5 and 6, into the hole in the line of the proposed fracture, thus cutting two V-shaped grooves into the walls of the hole. The blacksmith tools for dressing the reamers are shown in Fig. 7. The usual method of charging and tamping a hole in using the new system is shown in Fig. 8. The charge of powder is shown at *C*, the air-space at *B* and the tamping at *A*. Fig. 9 is a special hole for use in

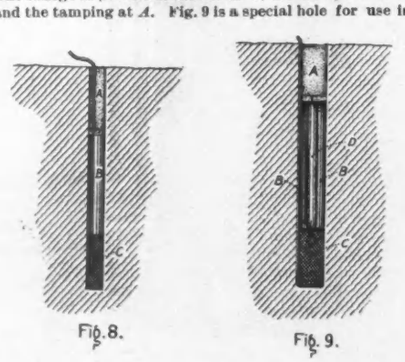

Fig. 8. Fig. 9.

thin beds of rock. The charge of powder is shown at *C*, the rod to sustain tamping at *D*, air-space at *BB* and tamping at *A*.

Let us assume that we have a bluestone quarry, in which we may illustrate the simplest application of the new system. The sheet of stone which we wish to shear from place has a bed running horizontally at a depth of say 10 ft. One face is in front and a natural seam divides the bed at each end at the walls of the quarry. We now have a block of stone, say 50 ft. long, with all its faces free except one—that opposite and corresponding with the bench. One or more of the specially formed holes are put in at such depth and distance from each other and from the bench as may be regulated by the thickness, strength and character of the rock. No man is so good a judge of this as the quarry foreman who has used and studied the effect of this system in his quarry. Great care should be taken to drill the holes round and in a straight line. In sandstone of medium hardness these holes may be situated 10, 12 or 15 ft. apart. If the bed is a tight one the hole should be run entirely through the sheet and to the bed; but with an open free bed holes of less depth will suffice.

The reamer should now be used and driven by hand. Several devices have been applied to rock drills for reaming the hole by machinery while drilling; that is, efforts have been made to combine the drill and the reamer. Such efforts have met with only partial success. The perfect alinement of the reamer is so important that where power is used this point is apt to be neglected. It is also a well known fact that the process of reaming by hand is not a difficult or a slow one. The drilling of the hole requires the greatest amount of work. After this has been done it is a simple matter to cut the V-shaped grooves. The reamer should be applied at the center, that is, the grooves should be cut on the axis or full diameter of the hole. The gage of the reamer should be at least 1½ diameters. Great care should be taken that the reamer does not twist, as the break may be thereby deflected; and the reaming must be done also to the full depth of the hole.

The hole is now ready for charging. The powder should be a low explosive, like black or Judson powder, or other explosives which act slowly. No definite rule can be laid down as to the amount of powder to be used, but it should be as small as possible. Very little powder is required in most rocks. Hard and fine grained stone requires less powder than soft stone. Mr. KNOX tells of a case which came under his observation, where a block of granite "more than 400 tons weight split clear in two with 13 ozs. of FF powder." He compares this with a block of sandstone of less than 100 tons weight "barely started with 2½ lbs of the same grade of powder, and requiring a second shot to remove it."

It is obvious that enough powder must be inserted in the hole to produce a force sufficient to move the entire mass of rock on its bed. In some kinds of stone, notably sandstone, the material is so soft that it will break when acted upon by the force necessary to shear the block. In cases of this kind a number of holes should be drilled and fired simultaneously by the electric battery. In such work it is usual to put in the holes only 4 or 5 ft. apart. The powder must, of course, be provided with a fuse or preferably a fulminating cap. It is well to insert the cap at or near the bottom of the cartridge, as shown in Figs. 8 and 9.

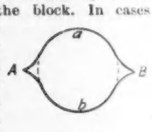

Fig. 10.

After the charge the usual thing to do is to insert tamping. In the improved form of hole the tamping should not be put directly upon the powder, but an air space should be left, as shown at *B*, Fig. 8. The best way to tamp, leaving an air space, is first to insert a wad, which may be of oakum, hay, grass, paper or other similar material. The tamping should be placed from 6 to 12 ins. below the mouth of the hole. In some kinds of stone a less distance will suffice, and as much air space as practicable should intervene between the explosive and the tamping. If several holes are used on a line they should be connected in series and blasted by electricity. The effect of the blast is to make a vertical seam connecting the holes, and the entire mass of rock is sheared several inches or more.

The philosophy of this new method of blasting is simple, though a matter of some dispute. The following explanation has been given. See Fig. 10.

"The two surfaces, *a* and *b*, being of equal area, must receive an equal amount of the force generated by the conversion of the explosive into gas. These surfaces being smooth and presenting no angle between the points *A* and the furnish no starting point for a fracture, but at these points the lines meet at a sharp angle including between them a wedge-shaped space. The gas acting equally in all directions from the center is forced into the two opposite wedge-shaped spaces, and the impact being instantaneous the effect is precisely similar to that of two solid wedges driven from the center by a force equally prompt and energetic. All rocks possess the property of elasticity in a greater or less degree, and this principle being excited to the point of rupture at the points *A* and *B*, the gas enters the crack and the rock is split in a straight line, simply because under the circumstances it cannot split in any other way."

Another theory which is much the same in substance is then given, and after some general discussion of the theory of the action of the forces under the several systems, the paper continues:

The new form of hole is, therefore, almost identical in principle with the old Portland canister, except that

has the greater advantage of the V-shaped groove in the rock, which serves as a starting point for the break. It is also more economical than the Portland canister in that it requires less drilling and the waste of stone is less. It is, therefore, not only more economical than any other system of blasting, but it is more certain, and in this respect it is vastly superior to any other blasting system, because stone is valuable, and anything which adds to the certainty of the break also adds to the profit of the quarryman.

It is doubtless true that, notwithstanding the greater area of pressure in the new form of hole, the break would not invariably follow the prescribed line but for the V-shaped groove which virtually starts it. A bolt, when strained, will break in the thread whether this be the smallest section or not, because the thread is a starting point for the break. A rod of glass is broken with a slight jar provided a groove has been filed in its surface. Numerous other instances might be cited to prove the value of the groove. Elasticity in rock is a pronounced feature, which varies to a greater or less extent; but it is always more or less present. A sandstone has recently been found which possesses the property of elasticity to such an extent that it may be bent like a thin piece of steel. When a blast is made in the new form of hole the stone is under high tension, and being elastic it will naturally pull apart on such lines of weakness as grooves, especially when they are made, as is usually the case in this system, in a direction at right angles with the lines of least resistance.

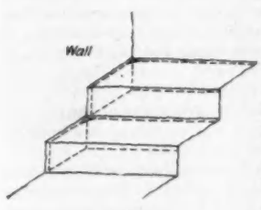

Fig. 11.

Horizontal holes are frequently put in and artificial beds made by "lofting." In such cases where the rock has a "rift" parallel with the bed, one hole about half way through is sufficient for a block about 15 ft. square, but in "liver" rock the holes must be drilled nearly through the block and the size of the block first reduced.

A more difficult application of the system, and one requiring greater care in its successful use, is where the block of stone is so situated that both ends are not free, one of them being solidly fixed in the quarry wall. A simple illustration of a case of this kind is a stone step on a stairway which leads up and along a wall, Fig. 11. Each step has one end fixed to the wall and the other free. Each step is also free on top, on the bottom and on the face, but fixed at the back. We now put one of the new form of holes in the corner at the junction of the step and the wall. The shape of the hole is as shown in Fig. 11.

It is here seen that the grooves are at right angles with each other, and the block of stone is sheared by a break made opposite and parallel with the bench, as in the previous case, and an additional break made at right angles with the bench and at the fixed end of the block. Sometimes a corner break is made by putting in two of the regular V-shaped holes in the lines of the proposed break and without the use of the corner hole. A useful application of this system is in splitting up large masses of loose stone. For this purpose the V-shaped grooves are sometimes cut in four positions and breaks are made in four directions radiating from the center of the hole as shown in Fig. 12. In this way a block is divided into four rectangular pieces.

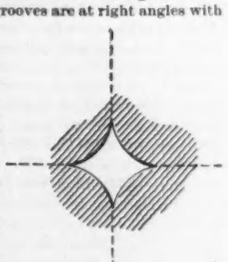
Fig. 12.

Though the new system is especially adapted to the removal of heavy masses of rock, yet it has been applied with success in cases where several light beds overlie each other. In one such instance 10 sheets, measuring in all only 6 ft., were broken by a blast, but in cases of this kind the plug and feather process applies very well, and the new system, when used, must be in the hands of an expert, or the loss will be serious.

Referring again to our stone step, let us imagine a case where this stairway runs between two walls. We have here each step fixed at each end and free only on the top, the bottom, and one face. Let us assume that there is a back seam, that is, that the step is not fixed at the back. In a quarry, this seam, unless a natural one, should be made by a channeling machine. In order to throw this step out of place it must be cut off at both ends, and for this purpose the V-shaped holes are put in at right angles to the face. It is well, however, to put the first two holes next the back seam in a position where the grooves will converge at the back so as to form a sort of key which serves a useful purpose in removing the block after the blast. In quarries where there are no horizontal beds a channeling machine should be used to free the block on all sides and to a suitable depth, and then the ledge may be "lofted" by holes placed horizontally.

Where "pressure" exists in quarries, the new system has certain limitations. After determining the line of "pressure" it is only practicable to use the system directly on the line of thrust, or at right angles to it. It is much better, however, to release the "pressure" from the ledge by channeling, after which a single end may be detached by a Knox blast. It is well to bear in mind that the holes should invariably be of small diameter. In no case should the diameter of hole be over 1½ in. in any kind of rock. This being the case, the blocks of stone are delivered to the market with but little loss in measurement. It is a noticeable fact that stone quarried by the new system shows very little evidence of drill marks, for the faces are frequently as true as though cut with a machine.

A further gain is the safety of the system. The blasting is light and is confined entirely within the holes. No spalls or fragments are thrown from the blast.

The popular idea that the system is antagonistic to the channeling process is a mistaken one. There are, of course, some quarries which formerly used channeling machines without this system, but which now do a large part of the work by blasting. Instances, however, are rare where the system has replaced the channeler. The two go side by side, and an intelligent use of the new system in most quarries requires a channeling machine. There are those who may tell of stone that has been destroyed by a blast on the new system, but investigation usually shows that either the work was done by an inexperienced operator, or an effort was made to do too much.

A most interesting illustration of the value of this system, side by side with the channeler, is shown in the northern Ohio sandstone quarries. A great many channeling machines are in use there working around the new form of holes, and when used together in an intelligent and careful manner the stone is quarried more cheaply than by any other process that has yet been devised.

To a limited extent the system has been used in slate. The difficulty is that most of the slate quarries are in solid ledges, where no free faces or beds exist; but it has been used with success in a slate quarry at Cherryville, Pa., since 1888. Among notable blasts made by this system are the following: At the mica schist quarries, at Conshohocken, Pa., a hole 1½ in. in diameter was drilled in a block which was 27 ft. long, 15 ft. wide and 6 ft. thick. The blast broke the stone across the "rift," only 8 oz. of black powder being used. At the Portland, Conn., quarries a single blast was fired by electricity, 15 holes being drilled with 2 lbs. of coarse No. C powder in each hole, and a rock was removed 110 ft. long, 20 ft. wide and 11 ft. thick, containing 24,200 cu. ft., or about 2,400 tons, the fracture being perfectly straight. This large mass of stone was moved out about 2 in. without injury to itself or the adjoining rock.

Another blast at Portland removed 3,300 tons a distance of 4 ins. Seventeen holes were drilled, using 2 lbs. of powder in each hole, the size of the block being 150 × 20 × 11 ft. In a Lisbon, O., quarry a block of sandstone 200 ft. long, 28 ft. wide and 15 ft. thick was moved about ½ in. by a blast. This block was also afterward cut up by this system into blocks 6 ft. square. A sandstone boulder 70 ft. long, average width 50 ft., average thickness 13 ft., was imbedded in the ground to a depth of about 7 ft. A single hole 8 ft. deep was charged with 20 oz. of powder, and the rock was split in a straight line from end to end and entirely to the bottom. A ledge of sandstone open on its face and two ends, 110 × 13 × 8 ft., was moved by a blast about 3 ins. without wasting a particle of rock, 8 holes being used, drilled by three men in just one day, and 15 oz. of powder being used in each hole. A sandstone ledge, open on the face and end only, 200 × 28 × 15 ft., containing 84,000 cu. ft. of stone, was moved ½ in. by 25 holes, each containing 1 lb. of powder.

The Railways of Austria.

In the Reports of the Consuls of the United States, for August, 1891, Consul-General JULIUS GOLDSCHMIDT, of Vienna, treats at great length of the commerce and industries of Austria-Hungary. The part relating to railways may be abstracted as follows:

The construction of railways has been greatly stimulated lately by a government guarantee of interest and the amortization of the capital invested in railways. The guaranteed interest is usually 5% and the amortization one-fifth of 1%. If the proceeds from the working of the roads do not meet expenses the deficit is advanced by the state, and these sums appear in the annual budget under the head of "subventions," and the state may at any time take possession before the expiration of the usual term of 90 years.

The total length of all lines in Austria-Hungary in November, 1890, was 16,286 miles, an increase of 415.4 miles in the year 1889-90. The number of passengers carried from January to November, 1890, was 55,660,353, showing an increase of 16,476,496, as compared with the same period in 1888-9. This increase is due to the late introduction of the so-called zone tariff on several lines. This zone tariff works differently in Austria and in Hungary. In the first named country it is principally in favor of the neighboring traffic, and in the latter it offers the greatest advantage to the greater distance. The results of the system for the 11 months of 1889-90 show that on the Austrian lines each increase of a passenger only means an increase of 0.22 kreutser in receipts, against an increase of 17½ kreutsers in Hungary.

The total length of Austrian railways is 11,135 miles, with an invested capital of about $1,200,000,000 gold. These lines are divided into state railways, or *Staatsbahnen*, and roads worked and owned by private corporations, or *Privatbahnen*. The state railways aggregate 3,035 miles in length, with 1,080 locomotives, 900 tenders, 2,500 passenger cars, 700 mail cars and 18,000 freight cars. The capital stock invested in the construction or acquisition of the lines and subsequent investment amounts to about 800,000,000 florins, or say $344,000,000. According to the reports of 1887-88 there was a surplus earning of about 2.5% on the capital invested. The general direction of these lines is assisted by the *Eisenbahnrath*, a consulting committee, made up of influential real estate owners, merchants, manufacturers and farmers. Many beneficial railway reforms owe their origin to this body.

The private railways of Austria have a length of 6,820 miles, with a capital stock of 2,000,000,000 florins, or $860,000,000. In this length of line given about 3,600 miles of railway extend over both Austria and Hungary. While the net revenue varies greatly, it may be said that the solid roads generally yield from 6 to 8%. There are also about 620 miles of *Lokalbahnen*, or local railways, built at a cost of about 33,500,000 florins. The government now patronizes these roads by grants of money, exemption from taxes, &c.

The Hungarian state railways aggregate about 3,410 miles in length, with 750 locomotives, 650 tenders, 2,050 passenger cars, and 16,500 freight cars. There are no official records of the cost of these roads. There are about 1,550 miles of private and local lines in Hungary, extending into Austria as before mentioned.

The zone passenger tariff, in Hungary, went into effect on Aug. 1, 1889, and the system has so far proved so advantageous, both to the traveling public and to the profitable working of the lines, that it is being extended to Austria and in part of Germany. This tariff divides traveling on main lines into 14 principal classes, and that on branch lines into two classes. These classes are called zones, and for one or more of these zones tickets are issued good for a trip from the starting point to the end of the zone or any point within it. The following table shows the division into zones and the prices for fares:

Number of zone.	Description.	Local trains.			Fast trains.		
		1st class.	2d class.	3d class.	1st class.	2d class.	3d class.
Short lines.		Florins.	Florins.	Florins.	Florins.	Florins.	Florins.
1	First station	0.30	0.15	0.10	.....	.....	.....
2	Second station	.40	.22	.15	.....	.....	.....
Main lines.							
1	1 to 25 kilom'tr's	.50	.40	.25	0.60	0.50	0.30
2	26 to 40 "	1.00	.80	.50	1.20	1.00	.60
3	41 to 55 "	1.50	1.20	.75	1.80	1.50	.90
4	56 to 70 "	2.00	1.60	1.00	2.40	2.00	1.20
5	71 to 85 "	2.50	2.00	1.25	3.00	2.50	1.50
6	86 to 100 "	3.00	2.40	1.50	3.60	3.00	1.80
7	101 to 115 "	3.50	2.80	1.75	4.20	3.50	2.10
8	116 to 130 "	4.00	3.20	2.00	4.80	4.00	2.40
9	131 to 145 "	4.50	3.60	2.25	5.40	4.50	2.70
10	146 to 160 "	5.00	4.00	2.50	6.00	5.00	3.00
11	161 to 175 "	5.50	4.40	2.75	6.60	5.50	3.30
12	176 to 200 "	6.00	4.80	3.00	7.20	6.00	3.60
13	201 to 225 "	7.00	5.30	3.50	8.40	6.50	4.20
14	226 kilometres and over	8.00	5.80	4.00	9.60	7.00	4.80

The florin is now about $0.43.

The passengers' baggage is also divided into three classes or zones; but there is no free baggage. The charges are as follows:

Distance.	Weight— 1 to 50 kilos. Florins.	51 to 100 kilos. Florins.	101 kilos and over. Florins.
1 to 55 kilometres	0.25	0.50	1.00
56 to 100 kilometres	0.50	1.00	2.00
101 kilometres and over	1.00	2.00	4.00

The comparative cheapness of travel under this system is made evident from the following comparison of various railway lines for first-class tickets for a distance of 70 kilometres, or 43.4 miles:

Railway Lines.	Fast trains, Florins.	Local, Florins.
Austro-Hungarian State lines.	3.37	2.71
Branch lines	0	3.21
Southern Railway	5.42	4.54
Hungarian State lines (4th zone)	2.40	2 00

This ratio of difference increases with the distance traveled and is greatest for distances of over 225 kilometres. As a result the surplus receipts from passenger fares for November, 1889, exceeded that of the November of the preceding year by nearly 20 per cent.

Although at the time of the introduction of the zone tariff the number of passengers forwarded by the 4,900 kilometres of Hungarian State railroad remained considerably behind the number of passengers forwarded during the same period of the preceding year—the results of that preceding year being considered as very unfavorable—the number forwarded on the lines was increasing at such a rate that, according to official statistics reaching to the end of November, 1889, there were sold during that month of November 947,669 passenger tickets yielding a receipt of 710,208 florins, while for November of the preceding year (1888) 503,649 passenger tickets were sold with the receipt of 595,133 florins, thus showing for November, 1889, an increase of 444,020 passengers and 115,165 florins.

As a consequence of this favorable turn, not only the shortcomings were made up that had occurred at the commencement of the working of the zone tariff in the month of August, but the receipts from passenger tickets—which were 7,683,641 florins in 1888 and 8,235,215 florins in 1889—show an increase of 551,574 florins. The increase in the number of passengers is about 80 per cent.

What is still more striking is that this unexpectedly great success of the zone tariff is not confined to the year immediately following the introduction of that innovation; but the period from Aug. 1 to Sept. 20, 1890, shows another increase of passengers to the number of 475,578 and an increase of receipts of 56,078 florins compared with those of the same period of 1889, thus showing that, in spite of the sudden and mighty rise of traffic caused by the first year's working of the zone tariff, the increase is still continuing.

For freight traffic a similar radical reform has been worked out by the Hungarian minister of commerce. By this ordinance three zones of distances are established for the forwarding of freight: (1) from 1 to 200 kilometres, (2) 201 to 400 kilometres, (3) 401 kilometres and over. For each of these zones a uniform tariff is fixed, which is by 33 per cent. less than the former average tariff for the conveyance of goods.

Method Used to Determine the Best Capacity to Give to Basin No. 5, Boston Water-Works.*

The proper size for a storage reservoir on a given watershed is often difficult to determine. The following study was made of the subject when the question arose in connection with the building of Basin No. 5, on Indian Brook, in the Sudbury River watershed.

There are three important factors to observe: 1. The area of the watershed. 2. The topography of the site. 3. The cost.

In all the computations for Basin 5 the area of the watershed was taken at 5.9 sq. miles. The topography indicated that there were three important grade lines which it was desirable to investigate. These were 290, 295 and 300 ft. above datum. They flooded respectively 185, 225 and 570 acres and the relative capacities of the storage reservoirs built at these three levels were found to be 1,259,711,250 galls., 1,603,000,000 galls. and 2,224,000,000 galls. It is thought by many engineers that 11 ins. of water collected in the course of a very dry year is a conservative assumption, but as will be seen later, this is too large a figure when gaged by droughts which have actually occurred within the last few years.

On the basis, however, of 11 ins. collected and with the usual deductions for water surfaces the Indian brook would yield 2,906,745 galls. daily. To equalize this flow requires, say, 348,000,000 galls. storage or 120 days' supply. It is evident that all storage above this amount can after being divided by 365 days, be added to the daily yield of the stream. In the case of the 290 flow line this gives 2,495,600 galls. daily to add to 2,906,745, making 5,402,345 galls., and the same treatment pursued with the other two flow lines gives 6,342,862 and 7,860,369 galls. per day respectively.

The next step was to put these three basins through a severer ordeal. An accurate record has been kept for a number of years on the Sudbury River watershed, of the actual monthly collections per square mile. A period was selected embracing two years of maximum drought, 1881 and 1883. This period extended from 1878 to 1884 inclusive. The basins were supposed to be full in 1878, and, after crediting the stream for what it would have yielded monthly, it was found that the greatest amount which could be drawn from the 290 basin was only 4,481,000 galls. daily, from the 295 basin only 4,691,559 galls., and from the 300 basin but 4,718,680 galls. daily.

This is the best actual measure that we have of the relative values of these reservoirs. It is well to consider that there should be at all times at least one month's supply of water on hand, even after a basin is supposed to be exhausted, and on this basis the above figures would be still further reduced in the case of the 290 basin to 4,442,534 galls. daily supply. From the point of view of actual experience it will be seen that there is practically no difference in the values of the basin with 295 and 300 flow lines.

The cost, exclusive of land damages, was estimated at $650,302 for the 290 basin, $742,521 for the 295 and $1,082,697 for the 300 basin. The cost per million gallons on the basis of one dry year, with 11 ins. collection, was found to be $13.19, $12.83 and $15.09 for the 290, 295 and 300 basins respectively. On the basis of the delivery of water during the period from 1878 to 1884 the cost per million gallons was found to be $15.89, $17.34 and $25.14. Taking into account land damages and all expenses, it is probable that the basin with the 300 grade flow line would cost almost double that with a 290 flow line and would prove but of little more actual value for the purpose of delivering water during a protracted season of drought.

BOSTON WATER-WORKS.

DATA USED TO DETERMINE FLOW LINE OF INDIAN BROOK RESERVOIR.

Watershed 5.9 square miles.	Grade 290.	Grade 295.	Grade 300.
Flowage area	185 acres.	235 acres.	570 acres.
Capacity in gallons	1,259,711,250	1,603,000,000	2,224,000,000
Daily yield in gallons one dry year with 11 ins. collected	5,402,345	6,342,862	7,860,369
Daily yield in gallons from 1878 to 1884	4,481,000	4,691,559	4,718,680
Cost of reservoirs.	$650,302	$742,521	$1,082,697
Cost per million gallons delivered, one dry year	$13.19	$12.83	$15.09
Cost per million gallons delivered 1878-1884	$15.89	$17.34	$25.14

I have said nothing about the questions of raising of roads, shallow flowage, &c. These must be studied for each particular case, but I have given you the general outlines of the investigation, and they are those which can be used elsewhere on other watersheds.

* By DESMOND FITZGERALD, in the Journal of the Association of Engineering Societies, September, 1891.

Tests of Fireproofing Material.

Messrs. C. J. H. WOODBURY, C. M. GODDARD and D. L. LORD have prepared an official report on the recent Boston experiments on fireproofing construction, described and illustrated in our issue of Oct. 31, in which, after detailing the condition of each cell after the tests, they say:

In conclusion we would say that the heat of the fires apparently exceeded that of an ordinary burning building and that the results of these experiments are exceedingly valuable and reflect a great deal of credit upon the enterprise of their projectors.

Among the principal facts established at this test we wish to call attention to the great resistance to fire afforded by the solid plank construction, the walls being in themselves adequate to prevent the spread of a fire until it has reached a quite large extent; and such construction should in many instances be used in place of ordinary joisted partition. While it is not claimed that such solid plank partitions are equal to a brick division in resistance to fire, yet there are many places where the difficulty of supporting a brick wall would render such a division out of the question, and yet a plank partition could be placed as readily as one supported on joist.

The porous terra-cotta lumber and the Eastern plaster board both presented a high resistance to heat, and were unaffected by exposure to the fires.

The secure bond of the wire lath, especially when reenforced by band iron, proved the value of this material in securely holding plasters when exposed to fire.

The Magneso-Calcite proved its value for re-enforcing tinned fire-doors and shutters, resisting the fire, and yielding only when the material to which it was attached fell.

The King's Windsor cement dry mortar resisted the fire in a most efficient manner when the support at the back remained, and, moreover, did not crumble as a result of heat or of streams of water played upon it when hot, as was the case with the ordinary lime mortar.

A Proposed New Kind of Water Gas.

Messrs. J. C. REISSIG and J. LANDIN have invented and patented a process for producing a water gas which shall be nearly all hydrogen, instead of only half hydrogen, which may be described as follows: In the ordinary process, when steam is passed through incandescent carbonaceous fuel, maintained at 1,000° to 1,400° F., a gas is produced which consists mainly of hyhrogen and carbonic acid, with only small quantities of carbonic oxide. When the fuel is maintained at a higher temperature, the proportion of carbonic oxide increases until at a temperature of 1,800° F., the resulting gas consists of a mixture of about 40% of carbonic oxide and 50% of hydrogen, with only about 5% of carbonic acid. This is known as water gas, and its use is often objected to on account of the poisonous properties of the carbonic oxide contained. The main object of the improvement is to produce a gas containing but little carbonic oxide, and to increase its calorific power by removing the carbonic acid from the combustible gases. The process consists in passing steam (preferably superheated) or water through fuel contained in externally heated retorts, or in water gas generators, maintained at 1,000° to 1,400° F. The resulting gas, consisting of hydrogen and carbonic acid, in the proportion of 2 to 1, is cooled and freed from sulphur impurities in the usual way. It is then passed through an absorbing apparatus containing carbonates of alkali or alkaline earths, preferably solutions of sodium carbonates (soda) or potassium carbonate (potash). These substances readily absorb (especially under pressure) the carbonic acid, forming bicarbonates, from which the carbonic acid is easily removed by the action of a moderate vacuum, especially if aided by heat. The remaining gas, principally hydrogen, is ready for use, while the solutions are again available for repetition of the absorbing operations.

PEAT FUEL FOR LOCOMOTIVES is said to have been used for some time experimentally by the Vadstedna & Oderhogs Railway in Sweden, either separately or mixed with coal. A special trial of peat fuel recently took place in a locomotive hauling 10 cars. The firing was done with peat alone. The steam was kept at full pressure during the whole of the journey, even at the steepest grades, where fully dried peat was used. The steam pressure did not fall when cold water was being fed into the boiler. A week later a similar train was dispatched, coal alone being used as fuel, and four days later a similar trial took place, also with coal for fuel. Peat has, it is said, now been adopted as fuel, and as long as serviceable peat can be obtained it will continue to be used.

THE MANCHESTER CANAL WATER SUPPLY is alleged to be so foul as to be dangerous to health. A report from the "Manchester and District Sanitary Survey Society" on the subject, prepared with the view of promoting some attempt at the improvement of the waters of the River Irwell, shows that there are 36 towns in the watershed area of the Irwell, half of which will have to be persuaded to adopt some sewage purification scheme, to effect the object in view. Of the condition of the river the report says: "Practically, in dry weather, the water which is in the river is a putrescent mixture composed of one-half sewage, one-quarter clean compensation water, and one-quarter ground water flowing in through the various brooks." On the completion of the canal the area of water and mud exposed to the action of the atmosphere will be about 40 acres, of this "nasty compound" as the report calls it. Furthermore, an analysis shows that the water at present in the ship canal dock is much more polluted with organic matter than any of the samples from the river.

VENTILATING FANS driven by electric motors have been in use in the dining cars of the Chicago, Milwaukee & St. Paul Railway during the past summer, and have given good satisfaction.. A system of electrical ventilation for parlor and sleeping cars on the same road is proposed, but has not been tried as yet.

A UNIFORM RAILWAY GAGE FOR INDIA is not probable, says *Indian Engineering*, for while it is essential that the great trunk lines shall have a uniform gage, there is really room for both broad and narrow gages, and there is never likely to be a monopoly of either gage. The broad 5 ft. 6 ins. gage has become so clearly established in India that no one would now suggest that, as in England, it be changed. Of the total 17,000 miles in India, speaking in round numbers, 10,000 are standard gage and nearly 7,000 metre gage, that is, 3 ft. 3⅜ ins. These will doubtless always remain. The other lines, 2 ft. and 2 ft. 6 ins. lines, and the Nalhati 4 ft. line, may some day be converted, but this will at most be an insignificant matter, their total length being under 300 miles. We referred to this question in our issue of Oct. 17.

ELECTRIC TRACTION on the overhead wire system is to be tried by the South Staffordshire Tramway Co., England. At a meeting to provide means for raising the necessary money, Mr. CARRUTHERS-WAIN, the President, said that the time had come when something must be done to meet the objections of local authorities and the Board of Trade to the continuation of steam traction in the district, and particularly to the present engines. He considered that practically the company was left no alternative but the use of electricity, and that the overhead system would prove the most economical and satisfactory. A company is prepared to undertake the working at so much per mile, the charge to include cost of installation, maintenance and repair, and the directors anticipate a saving of 6 cts. per mile in working expenses. The tramway company owns lines on country and suburban roads, where the use of the overhead wires may be admissible, but this system is not adapted for city streets and has been found objectionable in many ways in this country. It may be noted that the fall of an overhead wire on a suburban electric railway at Brooklyn, N. Y., last week, resulted in the death of 3 horses which were touched by the hanging wire.

PERSONALS.

Mr. EDWARD Y. TOWNSEND, President of the Cambria Iron Co., died at Bryn Mawr, Pa., Nov. 5.

Mr. E. S. LAWRENCE, Chief Engineer of the Zanesville Terminal Ry., has been appointed Chief Engineer of the West Florida & Georgia Ry.

Mr. C. D. MILLER, of Chicago, Ill., has been appointed Chief Engineer of the Iron Range & Huron Bay Ry., now being built in northern Michigan, vice Mr. MILO DAVIS resigned.

Mr. D. H. CONKLIN, General Superintendent of the South Atlantic & Ohio R. R., has been appointed General Manager of that road, with headquarters at Bristol, Tenn., and has also been elected Vice-President of the Virginia, Tennessee & Carolina Steel & Iron Co., which is controlled by the same parties.

Mr. HENRY M. SPERRY has been appointed general agent of the Johnson Railroad Signal Co., of Rahway, N. J Mr. SPERRY is an expert signal engineer. He has been in the service of the Pennsylvania R. R. for the past 10 years, and since 1887 has been Supervisor of Signals of the New York division. His office will be in Chicago, Ill.

Prof. JOHN FRANCIS WILLIAMS, Ph. D., assistant professor of geology and mineralogy in Cornell University, died on Nov. 9, aged 29 years. He graduated from the Troy Polytechnic Institute, studied at Gottingen and Berlin, and was later an instructor in Clark University. His chief work was his very complete report on the petrography of Arkansas, prepared for the State Survey, and just ready for publication.

Mr. ALFRED C. HOBBS, the inventor of the famous lock of that name, died at Bridgeport, Conn., on Nov. 6. Mr. HOBBS was born in Boston Oct. 7, 1812, and at the age of 13 was employed in a lock-making concern in New York. While there he invented his lock and became famous as a picker of locks of all other makes. In 1851 he visited London and won the 200 guineas reward offered to any one who would open the wonderful lock made by BRAHMA. He established the now very extensive firm of Hobbs, Hart & Co., in London, and in 1860 returned to the United States and took charge of the Howe Sewing Machine Works, in Bridgeport, and later of the Union Metallic Cartridge Wo ks, of the same place. He retired from active business in 1888, and was succeeded by his son, Mr. ALFRED J. HOBBS, the present superintendent.

Mr. J. GREGORY SMITH, President of the Central Vermont R. R. since 1873, died at St. Albans, Vt., Nov. 6. He was born at St. Albans, July 22, 1818, and was the son of JOHN SMITH, a prominent figure in Vermont railway and political circles. He studied law and was admitted to the bar in 1841. In 1849 he began his railway career as counsel for the Vermont Central R. R. and the Vermont & Canadian R. R. From 1857 to 1873 he was one of the receivers of the Vermont Central R. R. He was one of the projectors of the Northern Pacific R. R., and upon the organization of the company in 1866 he was chosen a director and made its president. Under his management the sum of $5,600,000 was subscribed, and during the time that he was president—1866 to 1873—the line was built from Lake Superior westward 450 miles. For over 40 years he had been the head and front of the roads now comprised in the Central Vermont system. He was elected governor of Vermont in 1863 and 1864.

Mr. JOHN M. GOODWIN, M. Am. Soc. C. E., of Sharpsville, Pa., died Nov. 2, aged 58 years. He was at one time Chief Engineer of the Michigan Southern & Northern Indiana Ry., now the Toledo & Chicago division of the Lake Shore & Michigan Southern Ry., and was prominently identified with the project for building a ship canal from Erie to Pittsburg, and had charge of the surveys of the route. He presented some important information relative to this project at the convention of the American Society of Civil Engineers at Lookout Mountain, Tenn., in May, 1891. A correspondent sends the following notes:

Before 1858 Mr. GOODWIN was engaged on surveys and construction in Wisconsin; Mr. CHAS. PAINE was there also. He went to Toledo about 1858, and was Chief Engineer of the Michigan Southern & Northern Indiana R.R. During the war he was in Washington under P. H. WATSON, Assistant Secretary of War under EDWIN M. STANTON. Later he was engineer on the Franklin branch of the Lake Shore & Michigan Southern Ry. under Mr. CHARLES COLLINS. He lived in Cleveland, O., several years, made a map of the railway terminals there, which occupied him several years. About 15 years ago he removed to Sharpsville, Pa., as Superintendent and Engineer of the railway and mining interests of Pierce Bros. A railway about 15 miles long was built, which crossed the Erie & Pittsburg branch of the Pennsylvania system, and as the right of crossing was stoutly resisted by all the resources of that great corporation, it was not accomplished without great effort and much litigation, and the preparation of the case was largely the work of Mr. GOODWIN. Latterly Mr. GOODWIN had become associated with the proposed ship canal from Lake Erie to the headwaters of the Ohio River at Pittsburg. Mr. GOODWIN'S equipment as an engineer consisted not merely in being an expert computer and a finished and skillful designer and draftsman, but he was a man of great research and thoroughness, and was widely known as an able and vigorous writer and contributor to the technical press.

Mr. MONCURE ROBINSON, one of the pioneers of American railway engineering, died in Philadelphia on Nov. 10, aged 90 years. In our issue of April 20, 1889, we gave a portrait and a detailed biography of Mr. ROBINSON and would refer our readers to this sketch. We will only say here that Mr. ROBINSON was born in Richmond, Va., Feb. 2, 1802. In 1818 he was engaged as a volunteer in the topographic survey of the state, and in 1821 was one of the engineers on the James River Canal. In 1825 Mr. ROBINSON commenced the study of engineering at the Ecole des Ponts et Chaussées in Paris, and in 1827 he returned to the United States and was later engaged in locating the Pottsville & Danville Railway for STEPHEN GIRARD. In 1828 he made the surveys for the Allegheny Portage Ry., for the Canal Commissioners of Pennsylvania. After building various railways in Virginia and the Little Schuylkill in Pennsylvania, he was in 1834, Engineer of the Philadelphia & Reading Railway and in this capacity negotiated in England the first foreign loan for that corporation. He opened this line to traffic in 1838, and the Pottsville extension in 1842. Mr. ROBINSON designed the locomotive "Gowan & Marx," built by Eastwick & Harrison in 1838, and a report upon the performance of this engine by the French engineer M. CHEVALIER attracted the attention of the Czar NICHOLAS and the charge of the then proposed Russian railway system was offered to Mr. ROBINSON, but declined. After engagements on professional work in Georgia and other points in 1839, and after acting as a member of a commission to select the site for the Brooklyn dry-dock, Mr. ROBINSON retired in 1847 from all active engineering duty. Mr. ROBINSON was an Honorary Member of the American Society of Civil Engineers and also of the Engineers' Club of Philadelphia. His widow and eight children survive him, and among his sons are JOHN MONCURE ROBINSON, President of the Seaboard Air Line Railway, Dr. BEASLEY ROBINSON and EDMUND RANDOLPH ROBINSON, all of New York City.

NEW PUBLICATIONS.

—*The Practical Catechism.*—A Collection of Questions on Technical Subjects by Manufacturers and Others, and of Answers thereto. By ROBERT GRIMSHAW, M. E., Ph. D. New York: John Wiley & Sons. 16 mo., pp. 226, 4 cuts $1.25.

We presume there is a demand for such volumes as this, or they would not be so often published, at least not in succession by the same author, as has happened with the author of this work. The success of FORNEY'S "Catechism of the Locomotive" seems to have given a special impetus to the preparation of them, but of real analogy between an admirable and complete scientific treatise like that and such a hodge-podge of miscellaneous trash as this (for in the form given it is largely trash) there is none whatever. If the work can be said to attempt anything except to sell itself, it is to give a synopsis of all scientific knowledge in 253 pages, 16 mo. This it does with such elaboration that it takes 32 pages of small type to index the several subjects touched upon! It is quite useless to review such a work seriously. It has no immoral tendency, and as it is not likely to be purchased by any but silly and ignorant persons it may possibly do such more good than harm. Being plainly addressed to and intended for persons of this class, it is competing for a large market, which perhaps explains how so many of such works continue to appear.

—*Illinois Society of Engineers and Surveyors.* Report of the sixth annual meeting, held at Springfield, Ill., Jan. 28 to 31, 1891. Published by the Society, at Springfield. Paper, 8vo; pp. 192; illustrated. 50 cts.

This report contains the following papers: "The Distance to the Stars, and How Found," I. O. BAKER; "Peoria Water-Works," J. A. HARMAN; "Roads and Road Drainage," T. S. MCCLANNAHAN; 'Determining Standard Time by the Use of the Transit," D. H. DAVISON; "Pennington's Aerial Ship," G. C. HARVEY; "Cost of Bad Roads," I. O. BAKER; "Drainage and Sewerage of Cicero," J. W. ALVORD; "Office Records," E. A. HILL; "Probable Error," I. O. BAKER; "Improvement of Public Grounds," F. BALCOM; "Straightening and Deepening Water Courses," D. L. BRANCHER; "Mine Surveying," D. H. DAVISON; "Railway Safety Appliances," CHARLES HANSEL; "Cumberland Gap Tunnel," J. F. PARR; "Principles of the Electric Motor," C. J. MITCHELL; "Early Surveyors and Surveying in Illinois,' Z. A. ENOS. Topical discussions.

—*Cassier's Magazine.* Vol. I., No. 1. The Cassier Magazine Co., LOUIS CASSIER, President. Potter Building, New York. 8vo, pp 88, 25 cts.

This is a new venture into the field which was first opened by the *Engineering Magazine*, noticed by us some months ago, that of semi-popular engineering literature, served up in the usual monthly magazine style. While there is a general similarity between the two magazines, however, and both are very handsomely printed and illustrated, this new venture appears to be projected as a more strictly technical and more highly specialized periodical. Its articles in the current number at least are almost exclusively devoted to the steam engine and boiler, and include various reprints and many short notes. Included in the contents is an interesting article by Prof. R. H. THURSTON on the "Philosophy of the Multiple-Cylinder Engine," and also a sketch of Prof. THURSTON'S life, with a strikingly admirable portrait of him, one of the most lifelike engravings we have ever seen. It is an interesting evidence of the increasing prominence of the engineering profession that this new venture should be made with Mr. FORNEY'S monthly, the *Railroad and Engineering Journal*, as well as the *Engineering Magazine* as competitors in much the same field, and we wish it all success.

TRADE PUBLICATIONS.

—*Testimonials and References.*—H. Ward Leonard & Co., electrical engineers and contractors, New York. Paper, 3¾ × 5¾ ins.; pp. 32.

This little pamphlet contains testimonials, a list of plants, the electrical construction of which was done under the supervision of the company, and several press notices.

—*The Quarryman and Contractor's Guide.* How to Remove Rock at Least Cost. By ARTHUR KIRK, Pittsburg, Pa. Cloth, 4 Fo., pp. 147.

While this volume is published by Arthur Kirk & Son, dealers in powder and high explosives, and thus comes under the head of trade publications, it contains much information very useful to both contractors and engineers. The bulk of the work relates to blasting operations and appliances, and the hints given as to the safe and proper handling of explosives and the prevention of accidents are evidently the outcome of intelligent practice and experience. The book is full of cuts illustrating the plant and methods advocated. Quarrying and blasting machinery take up the latter part of the volume, and the information here given is also very useful.

SOCIETY PROCEEDINGS.

Southern and Southwestern Railway Club.—The club will meet at the Kimball House, Atlanta, Ga., Nov. 19, at 10:30 a. m. The subjects to be discussed are as follows: "Uniformity in Locomotive Performance Sheets," and in the methods of collecting and computing the data embodied in them; to be opened by Mr. Jas. Meehan, Supt. of Motive Power of the Queen & Crescent system; "Repair Work on Large Systems," should it be conducted in one large plant supplemented by numerous small ones capable of doing light repairs only, or should the work be conducted in several plants distributed over the system, each capable of handling all kinds of repairs? To be opened by Mr. W. H. Thomas, Supt. of Motive Power, East Tennessee, Virginia & Georgia R. R.

W. H. MARSHALL, Acting Secretary.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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GEO. H. FROST.....BUSINESS MANAGER

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COMING TECHNICAL MEETINGS.

American Society of Mechanical Engineers.—Annual meeting in New York; Nov. 16 to 20. Secy., T. R. Hutton, 121 W. 31st St.

Western Railway Club.—Nov. 17. Rooms, Rookery Building, Chicago.

Engineers' Society of Western Pennsylvania.—Nov. 17. Secy., J. H. Harlow, Pittsburg, Pa.

Boston Society of Civil Engineers.—Nov. 18. Secy., S. E. Tinkham, City Hall.

Engineers' Club of St. Louis.—Nov. 18. Secy., Arthur Thatcher, Room 801, Odd Fellows' Building.

American Society of Civil Engineers.—Nov. 18. Secy., Francis Collingwood, 127 East 23d St., New York.

Engineers' Club of Cincinnati.—Nov. 19. Secy., J. F. Wilson.

New York Railroad Club.—Nov. 19. Rooms, Gilsey House.

Scandinavian Engineering Society of Chicago.—Nov. 19. Secy., T. G. Pihlfeldt, 113 Adams St.

Southern and Southwestern Railway Club.—Nov. 19. "Uniformity in Locomotive Performance Sheets," "Repair Work on Large Systems," Kimball House, Atlanta, Ga. Secy., W. H. Marshall.

Montana Society of Civil Engineers.—Nov. 21. Helena.

Western Society of Engineers.—Dec. 1. Secy., J. W. Weston, 280 La Salle St., Chicago.

Engineers' Club of Minneapolis.—Dec. 3. Rooms, Public Library Bldg. Secy., F. W. Cappelen.

Association of Civil Engineers of Dallas.—Dec. 4. Secy., E. K. Smoot, 803 Commerce St.

Technical Society of the Pacific Coast.—Dec. 4. Secy., O. von Geldern, 819 Market St., San Francisco.

Swedish Engineers' Club.—Dec. 5. Secy., P. Valentine, At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia.

Northwest Railroad Club.—Dec. 5. Rooms, Union Station, St. Paul.

Civil Engineers' Society of St. Paul.—Dec. 7. Secy., C. L. Annan.

Engineers' Club of Kansas City.—Dec. 7. Rooms, Baird Building. Secy., H. Goldmark.

Atlanta Society of Civil Engineers.—Dec. 8. Secy., Parker N. Black, Room 39, Capitol Block.

Denver Society of Civil Engineers.—Dec. 8. Secy., Geo. H. Angell.

Northwestern Society of Engineers.—Dec. 8. Rooms, Occidental Block, Seattle. Secy., E. H. Warner.

Civil Engineers' Association of Kansas.—Dec. 9. Secy., J. C. Herring, Wichita, Kan.

New England Railroad Club.—Next meeting, Dec. 9. At United States Hotel, Boston. Secy., F. M. Curtis.

Civil Engineers' Club of Cleveland.—Dec. 11. Secy., A. H. Porter, 50 Euclid Ave.

Engineering Association of the Southwest.—Dec. 11. Secy., O. H. Landreth, Nashville, Tenn.

Northwestern Track and Bridge Association.—Dec. 11. Rooms, Union Station, St. Paul.

THE "telautograph" on which Prof. ELISHA GRAY has been working now for several years would seem to be at last a practical success if we may judge from the statement that the Gray Electrical Co. is now erecting a large building at Idlewild, Ill., for the purpose of constructing them. As yet all technical description of this instrument has been sedulously kept back from the public for reasons sufficiently obvious which Prof. GRAY'S experience in the invention of the telephone is well calculated to impress upon him with especial force. Prof. GRAY'S standing as an original inventor of the telephone, and of other important electrical devices, is such as to inspire confidence, and vague reports that this instrument had been at last perfected have been current for some time. There is therefore at least a strong probability that, as the telephone was the sensation of the Philadelphia Exposition, so the telautograph may be the sensation of the Chicago Exposition. We could not, even if we would, give any accurate description of this device, but from what has already become known in regard to its general nature it would seem to have an excellent chance of displacing both the telephone and the stock "ticker," as well as ordinary telegraphing instruments, when and if perfected. The problem which Prof. GRAY is understood to have now solved to his own satisfaction is this: Given an ordinary wire and ordinary telegraphing current, to reproduce in fac-simile on ordinary paper writing done with ordinary pencil and paper at a distant station, and this, not by indirect process, but by causing the pens of all the instruments in circuit to reproduce precisely the motions of the pen in the hand of the sender. If all reports are true, this result has been achieved by amazingly simple instruments, of a durable and inexpensive character. If it has been achieved, it is perhaps the greatest of all the long list of electrical marvels. We shall await further news in regard to it with great interest.

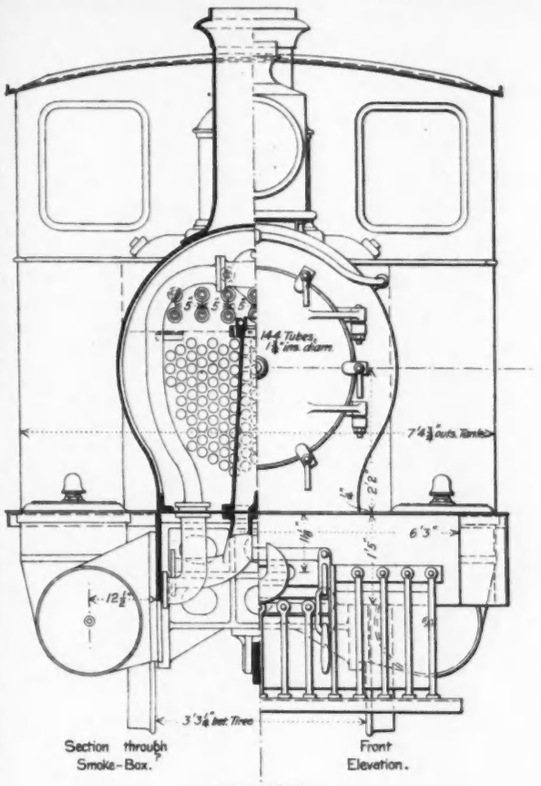
THE paper by Mr. THOS. ANDREWS abstracted in another column gives the results of the concluding series of his elaborate experiments on the effect of cold on the strength of railway axles, the first portions of which were described and illustrated in our issues of Feb. 18, 25, 1888. The investigation has been one of great value, conducted with much ability and thoroughness, and it ought, therefore, finally to set at rest this much vexed question. Mr. ANDREWS' experiments make it too clear for doubt that a temperature of 0° F. or even 32° F. very heavily increases the liability to fracture *from impact* of iron and steel. He finds that the difference between 100° and 0° is as great as between 428 and 180 ft.-tons of breaking force, or 42 per cent., and that the total bending before fracture is as 15.06 to 6.48, or 57 per cent. reduction. This is for 5 ft.-ton blows. For 10 ft.-ton blows the difference between 7° and 212° was as great as 235 per cent.; with 2½ ft.-ton blows the difference between 0° and 100° was as great as 88 per cent., and so on, as shown in the paper. All the details of the tests are recorded in full, and they have been quite extensive enough to eliminate all accidental sources of error.

On the other hand, equally elaborate experiments on the tensile strength of metals have shown directly contrary results. It has been shown many times over that the strength of metal against such static strains is not injuriously, if at all, affected by cold. One evident reason why this contrast should exist is the fact that, long before a tensile strain becomes great enough to cause fracture, the work done upon the metal in stretching it is great enough to warm it materially at the points where the yielding is greatest, and hence where it is most likely to break. Whether or not this is the only reason for the striking contrast it would be useless to speculate. In any case the result well illustrates that a widespread popular impression may be right even if seemingly scientific tests seem to disprove it. The difficulty in such tests is to secure truly comparable conditions. A practical conclusion which seems warranted by the facts is that axles or other metallic parts which are to be renewed only because of length of service, should be renewed in the fall instead of the spring. Any such part which has passed through a winter successfully is likely to go safely through the next summer.

THE two salient features of the safety appliance hearing in this city this week, as abstracted in another column, were an all but unanimous appeal by the railway officials against national legislation of any kind on the ground that they needed more time to insure right action, and a declaration from the representatives of switchmen and yardmen present that the present situation was confusion worse confounded, and they would prefer to go back to the old link and pin. We hope the committee of commissioners will not allow itself to be so influenced by either of these recommendations as to be deterred from decisively recommending *proper and reasonable* national legislation. It is needed for the protection of the very men who objected to it at the hearing. As respects the men, it is undoubtedly true that during the introductory stage, while there is a mixture of all kinds of couplers in service, car coupling is made more perilous rather than less so, and this for two reasons: (1) Car-coupling is like playing on the piano, a trick of hand, which must be performed semi-automatically to be done well. If a man has to stop and think, as he sometimes must when there are many types in service, he is lost. (2) Intercoupling of the new with the old type is for the above and other reasons an especially objectionable class (at least we think so, though this is denied), and the number of mixed couplings of this kind *increases* as the number of M. C. B. couplers in service increases, until more than half the car stock of the country is so equipped. Until that time also there are many times more intercouplings than of couplings of M. C. B. couplers with each other, which latter are relatively few in miscellaneous yard work until the half way point is reached. Why this is so was fully explained in our issue of April 25, 1891, in discussing "Why the Equipment of Freight Cars with Automatic Couplers Should Be Hastened." We content ourselves now with reproducing from that article the following table, which shows the reason in a nutshell:

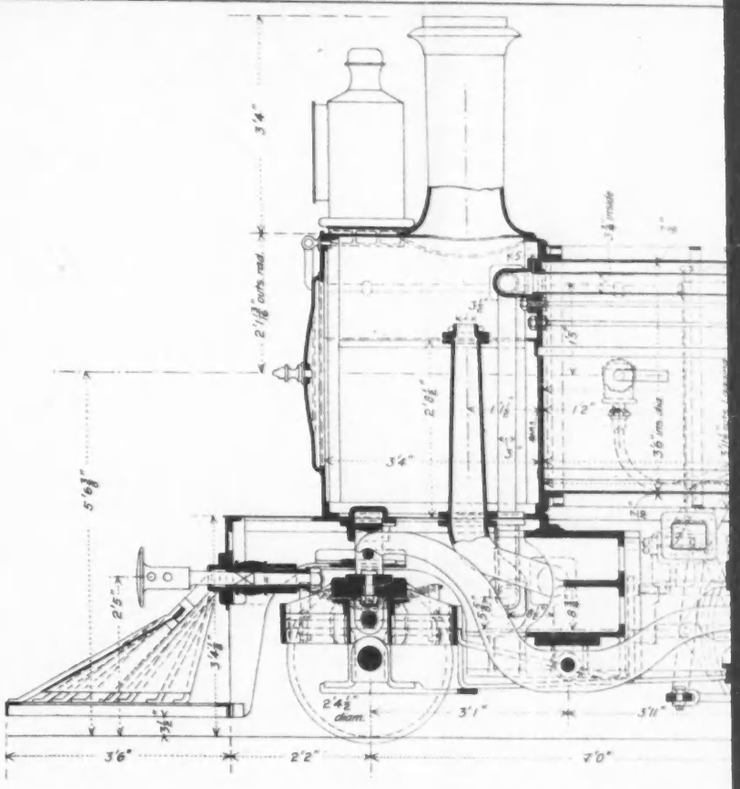
When the percentage of cars equipped with aut. couplers is	The percentage of couplings in yard work. Made automatically between M. C. B. cars is	Made by hand— Between M. C. B. and old style,	Between 2-link and pin cars,
10%	1	18	91
20%	4	32	64
30%	9	42	49
40%	16	48	36
50%	**25**	**50**	**25**
60%	36	48	16
70%	49	42	9
80%	64	32	4
90%	91	18	1

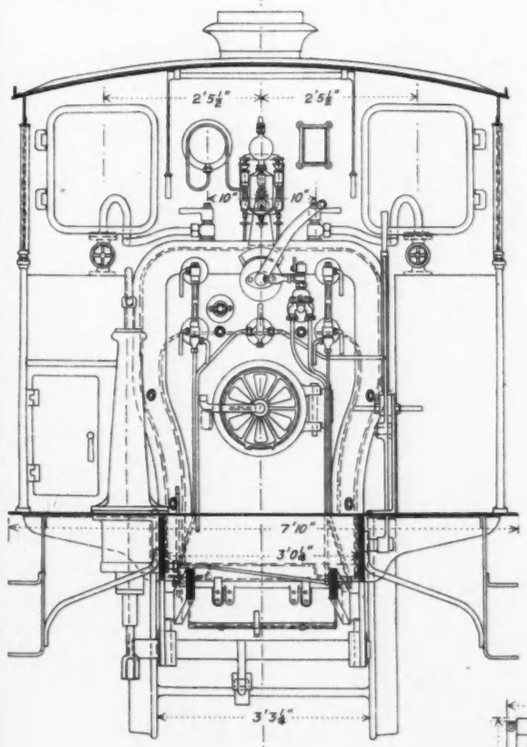
THIS table at once explains why the yardmen find the present status no improvement; and the reason why they are so desirous to end it by going backward rather than by going faster forward is perhaps not entirely disconnected with the labors of a little cabal of men who for reasons best known to themselves feel a strong interest in the Safford drawbar, a mere modification in form of the old style "bull-nose." As for the railway officials, there is great force in their plea that they should not be so tied down by legislation as to be forced into a "Chinese attitude" in regard to further improvements. No intelligent person disputes that legislative pressure in favor of any particular type of construction is an unmitigated evil, except under two conditions: (1) When absolute uniformity throughout the country is the first essential, and change in the type once adopted all but impossible, and (2) when experience has so far advanced as to give not only reasonable assurance, but practical certainty, that a particular type is well suited for the purpose, is purchasable in the market by the careful buyer at reasonable price and of reasonable quality, and is not likely to



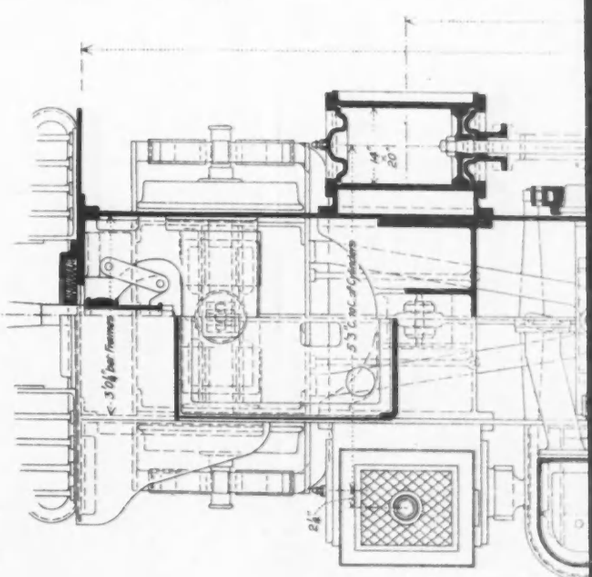
Section through Smoke-Box.

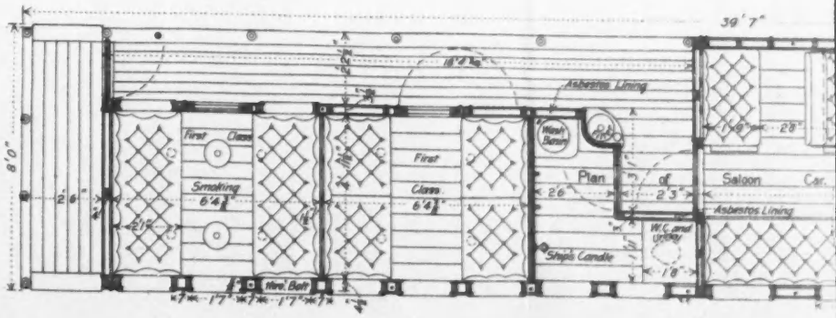
Front Elevation.





Section through Cab.





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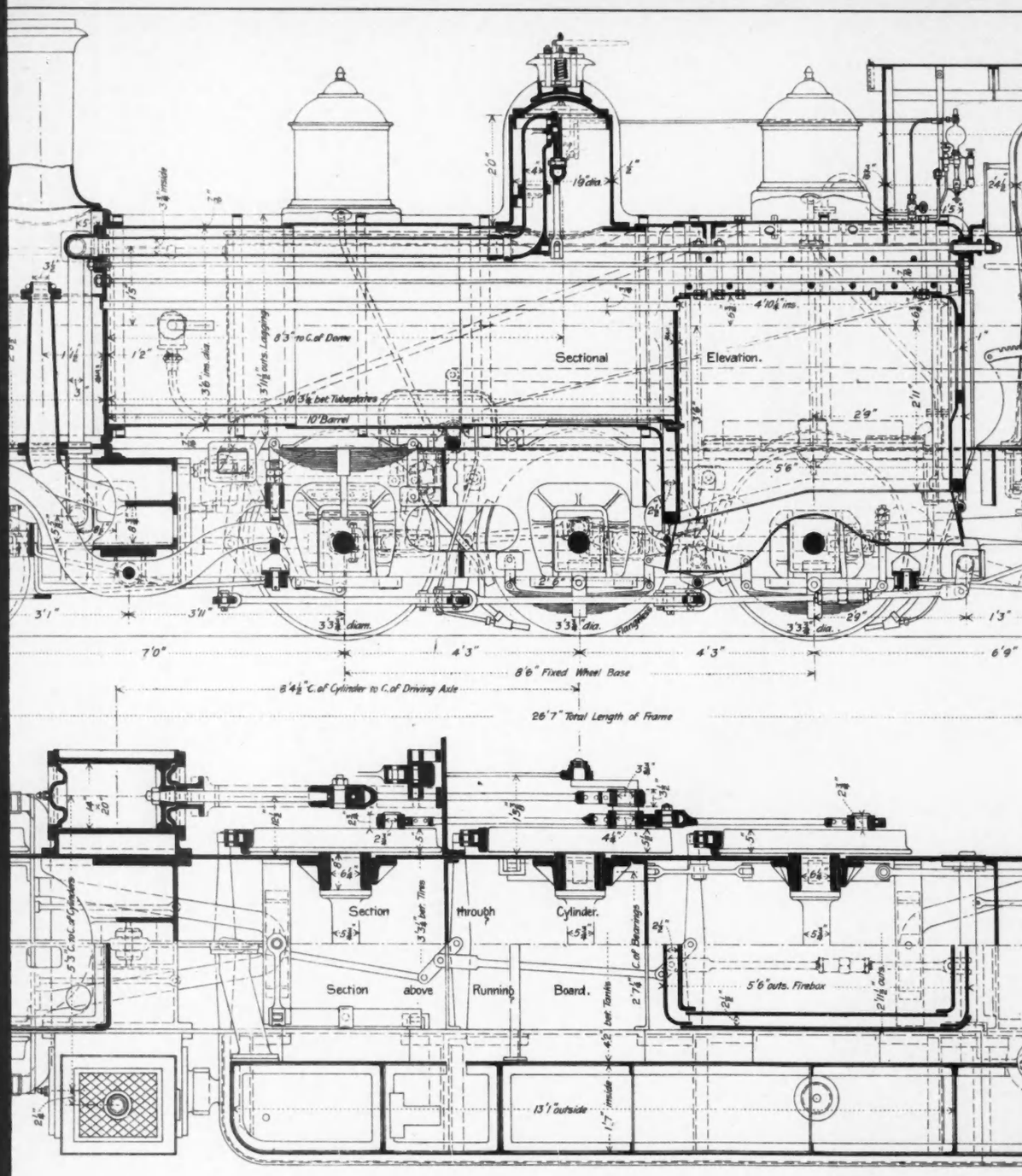

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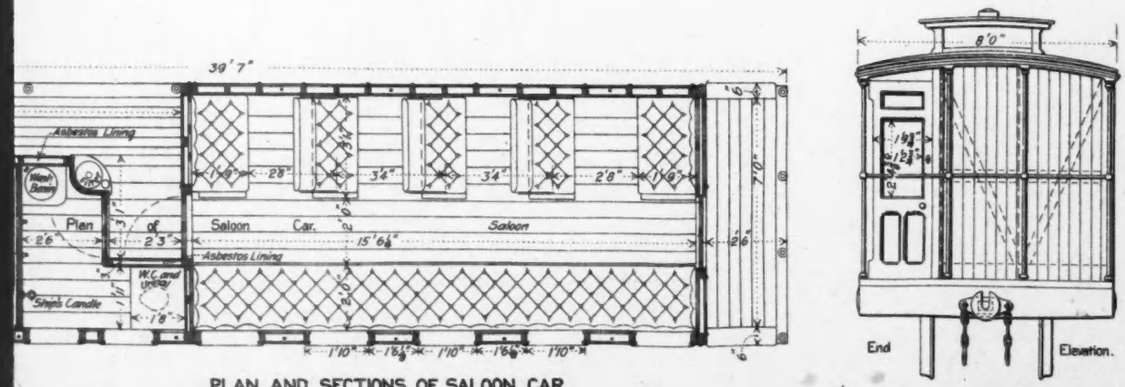
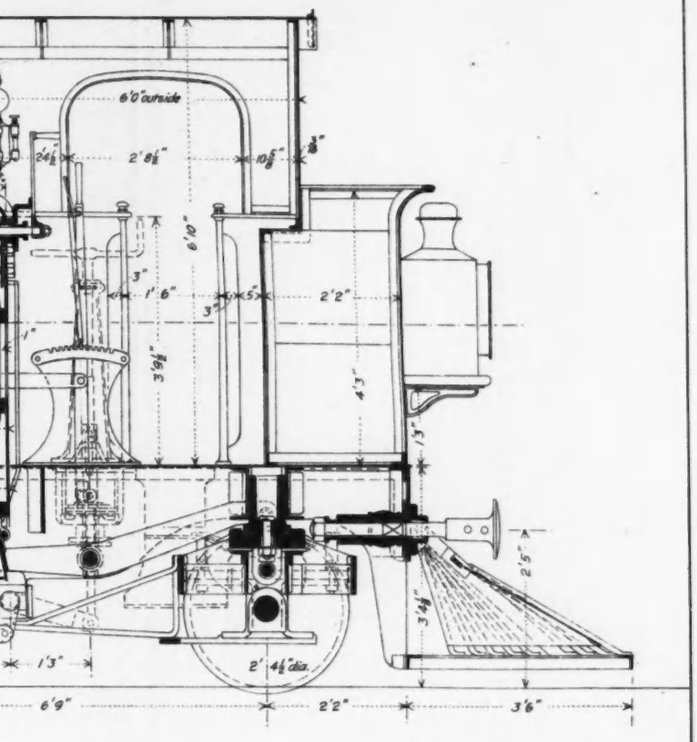
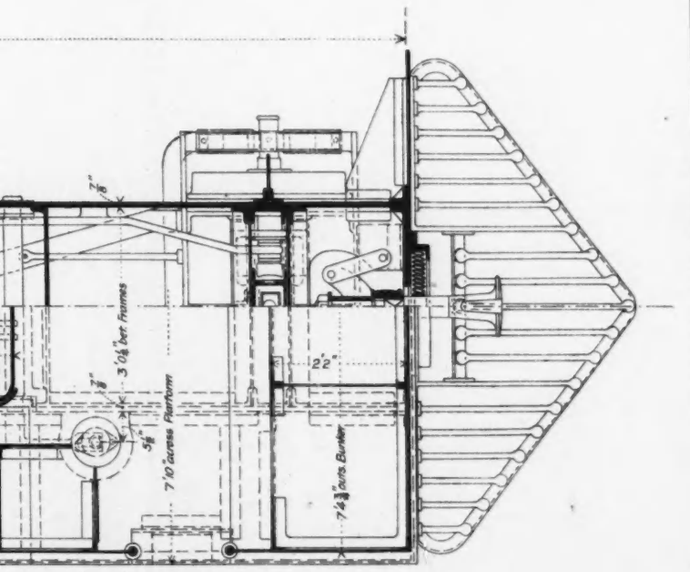


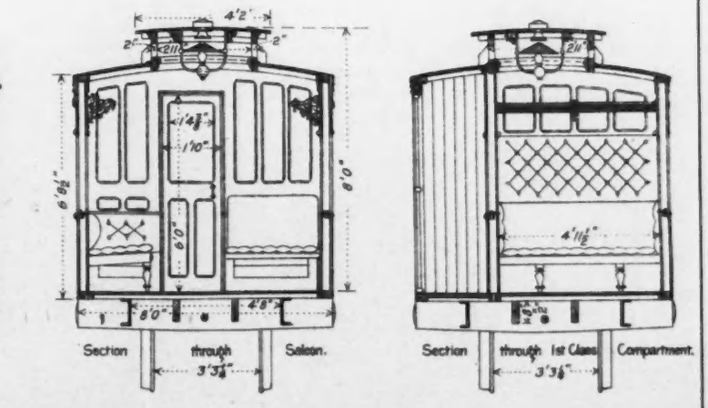
PLAN AND SECTIONS OF SALOON CAR.

E AND SALOON CAR FOR NEW ZEALAND GOVERNMENT RAILWAYS.

T. F. ROTHERAM, M. INST. C. E., LOCOMOTIVE SUPERINTENDENT.







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be materially improved upon. But both of these conditions already obtain in regard to the only thing which anyone proposes to make the subject of compulsory legislation, viz., the M. C. B. standard *lines* for the contact parts of the M. C. B. standard *type* of lateral hook couplers. These are now far past the possibility of material change without throwing away all the ground that has been gained, nor is there any discoverable wish for change among those who have heretofore led the forward movement. Such compulsory legislation will still leave open the questions of material, maker, interior construction, mode of attachment to the car, and other like questions on which indefinite progress may be expected, and which are never likely to be finally settled, nor need they be. And we hold it to be clear from the above table that compulsory legislation is needed not alone to shorten the period of transition with its temporary dangers, but to prevent those companies who deserve to gain most from the reform from gaining least, and the laggards who deserve to gain least from gaining most.

The Canadian Census.

The recently completed census of Canada, like the census of the United States, created a feeling of profound disappointment. In the United States the reported population was some 3,000,000 less than was expected, and the reported percentage of increase considerably less than had ever been known before; but still the absolute increase was great, so great in fact that the despised *increase* alone between 1880 and 1890 (12,466,467) is much more than the total English and French speaking population of all the British colonies, and very nearly one-third of the total population of Great Britain and Ireland.

In Canada, on the contrary, though the difference between the expected and reported population was far less absolutely (from 500,000 to 700,000), it was far greater relatively, and hence the discrepancy is of much greater moment. In fact, as we shall shortly see, it is when critically examined highly significant. The total population of the entire Dominion has been as follows for several succeeding censuses:

(000 omitted.)	1851.	1861.	1871.	1881.	1891.
Population	2,382	2,091	3,687	4,325	4,829
Per cent. increase	....	33.6	26.4	17.31	11.66
" " " U. S.	(1850) 35.87	(1860) 35.58	(1870) 22.63	(1880) 30.08	(1890) 24.86

We have extended this and the following tables two decades back of the figures given in the Canadian census bulletin, and in the above and following tables the percentages which we have computed are given to only one decimal, whereas those given in the respective census bulletins are to two decimals.*

Up to 1861 the percentages of decennial increase had run very nearly the same in both the United States and Canada, varying between 33.0 and 35.0, an enormous rate. During the war decade Canada gained on us. Since that date, while a tendency to a decreased rate of increase is visible in both countries, it will be seen to be vastly more marked in Canada. The chief reason for this is well understood and admitted, that there is a very large emigration from Canada to the United States, which seems to absorb not only the whole of the large emigration to Canada, but (in the last decade) about half of the natural increase in addition. When it is further considered that a very large percentage of the emigration to Canada does in fact remain there, the drain upon the native-born stock, which is the best stock, becomes of still more significance.

*The races of which the Canadian population was made up were, in 1881, in *thousands*, English, 883 (20.45); Scotch, 760 (16.28); Irish, 957 (22.15); French, 1,299 (30.15); German, 253 (5.89); Indian, 109 (2.55); other, 124 (2.96). In a rough way, we may say that the population is ⅓ English and Scotch, ⅓ French, and ⅓ Irish (chiefly) and "other." These returns refer *only to race, not to birthplace.* Of the 1881 population 14.15 was foreign born (*i. e.*, born outside of Canada), against 13.325 in the United States.

Let us see where and how this takes place: Considering Canada by groups of provinces, and comparing with the corresponding adjacent states of the United States, we have the following comparisons, the maritime provinces being given first, and compared with the adjacent states of New England:

	Population (1=1,000.)		
NORTH NEW ENGLAND.	1870.	1880.	1890.
Maine	627	649	661
New Hampshire	318	347	377
Vermont	331	332	332
Total	1 276	1,328	1,370
CANADA.	1871.	1881.	1891.
New Brunswick	286	321	321
Nova Scotia	384	441	451
Prince Edward Island	94	109	109
Total	767	871	881
SOUTH NEW ENGLAND.			
Massachusetts	1,457	1,783	2,239
Rhode Island	217	277	346
Connecticut	537	623	746
Total	2,211	2 683	3,331
Total New England	3,487	4,011	4,701

	Percentages of increase.			
NORTH NEW ENGLAND	1850-60.	1860-70.	1870-80	1880-90.
Maine	7.7	(d. 0.22)	3.52	1.87
New Hampshire	2.5	(d. 2.38)	9.01	8.51
Vermont	0.3	4.90	0.52	0.04
Mean	4.45	0.06	4.07	3.16
CANADA.				
New Brunswick	30.4	13.5	12.48	0.02
Nova Scotia	19.9	17.2	13.61	2.25
Prince Edward Island	24.6	16.0	17.19	0.18
Mean	24.1	15.5	13.45	1.17
SOUTH NEW ENGLAND.				
Massachusetts	23.7	18.38	22.35	25.57
Rhode Island	18.3	24 47	27.23	24.94
Connecticut	24.0	16.80	15.86	19.84
Mean	22.5	18.5	21.3	24.2
Total New England	14.93	11.25	14.98	17.01

These figures are worth careful study. They show that a great change has occurred in the development of the maritime provinces. During the period 1850–70 they grew with great rapidity, much faster than the New England States, for the obvious reason that the States were sending an enormous emigration westward, while the provinces (as we shall shortly see) were not. Since that date, the growth of the provinces has been steadily decreasing, until it may now be said to have practically ceased, while the growth of the New England States as a whole has been steadily increasing, and even the population of Maine, New Hampshire and Vermont is increasing three times as fast as the provinces, though it is well known that there is still a very large emigration westward from them, which is not the case from the provinces.

That this last is so, cannot yet be shown from the 1891 census, for the figures of birth place and residence are not yet out. But we have before us the statistics of the 1881 census, and with some labor condense from them the following tolerably decisive table:

	Out of those *born* in the			
There were *living* in the	Marit. Prov.	Ont. Quebec.	Man. and Br. C.	Total natives.
Maritime Prov.	797,417	4,493	13	801,923
Ontario, Quebec	9,864	2,765,508	362	2,775,734
Man. & Br. Columbia	2,119	25,796	159,920	187,835
Total native born	809,400	2,795,797	110,295	3,715,492
Percentage				
Of "stay-at-homes"	98.52	98.91	99.66	98.85
Of emig'ts to *either* of the other sections	1.48	1.69	0.34	1.15

It will be seen that the native-born Canadian population is (or was up to 1881), pre-eminently a stay-at-home population, as respects the three main groups of provinces into which the Dominion may be divided. Up to 1881 not less than 99 per cent. of them lived in the section in which they were born, and only 1 per cent. (and a small fraction) had removed to either of the other sections. No doubt there has been some considerable change since, due to the completion of the Pacific Railway and other causes, but as respects the maritime provinces it cannot be large, since up to 1881 only a handful of people from these provinces 9,864 against 4,493 in the reverse direction) had gone to Ontario and Quebec, with which communication was easy then as now.

This is in striking contrast to the tendency in the United States. With some considerable labor (which the U. S. census should save to individual investigators by more careful totaling) we compile a table corresponding to the above for the three states of north New England, as follows:

	Out of those *born* in—		
There were *living* in	Maine.	New Hamp.	Verm't.
North New England	578,506	263,995	268 302
South "	73,503	57,860	32,162
Elsewhere in United States	93,263	49.417	129,577
Total born in each state	745,272	371,262	430,041
Percentage of			
Stay-at-homes	77.60	71.10	62.34
Emig'ts to So. New England	9.88	15.60	7.48
" other Unit'd St'tes	12.52	13.30	30.18

It is difficult to escape the conclusion, therefore, that the greater portion of the natural increase of the Maritime Provinces, which may be some 200,000 per decade (22½ per cent.), is emigrating to somewhere, and chiefly to the United States, as increase of home population has practically ceased.

Coming now to the two great central provinces, which together contain about 75 per cent. of the Dominion's population, their growth as compared with adjacent states of the Union may be tabulated as follows:

	Population, 1 = 1,000		
UNITED STATES.	1870.	1880.	1890.
New York	4,383	5,083	5,998
Ohio	2,665	3,198	3,672
Michigan	1,184	1,637	2,094
Totals	8,232	9,918	11,764
CANADA.	1871.	1881.	1891.
Ontario	1,621	1,927	2,113
Quebec	1,192	1,359	1,489
Total	2,812	3,286	3,602

	Per cent. increase.			
UNITED STATES.	1850-60.	1860-70.	1870-80.	1880-90.
New York	15.9	12.94	15.97	18.00
Ohio	19.9	13.92	19.99	14.83
Michigan	38.2	58.06	38.25	27.92
Mean	27.3	18.2	20.5	18.6
CANADA.	1851-61.	1861-71.	1871-81.	1881-91.
Ontario	44.6	16.1	18.88	9.65
Quebec	24.9	7.2	14 05	9.53
Mean	36.1	11.95	16.83	9.60

Here also it will be seen that up to 1860, prior to which time there was no very important emigration to the United States, the population of the Canadian provinces was increasing much faster than that of the neighboring states to the south, which were sustaining a very heavy westward emigration. During the war decade, the provincial population increased very slowly, probably as an effect of the great demand for labor in the United States during the war. In the next decade (1871–81) there was a decided (if only partial) recovery, up to very nearly the rate of increase of the neighboring states, but since then there has been an even more decided drop, to the very low rate of 9.60 per cent. per decade, the natural increase alone being more than twice this.

Two explanations of this fact have been suggested, the emigration to the northwest provinces, and the growth of cities at the expense of rural population. To see to what extent the first is a probable explanation we may give for the great Canadian northwest the growth of population in the same form as for the other groups, comparing with our own states and territories along the border.

	Population (1 = 1000.)			Per cent. increase.		
UNITED STATES.	1870.	1880.	1890.	1860-70.	1870-80.	1880-90.
North Dakota	14.2	36.9	182.8	193.18	853.23	395.05
South Dakota		98.3	328.8			234.60
Montana	....	39.2	132.2	.....	90.14	237.49
Wyoming	9.1	20.8	60.7	.....	128.00	192.01
Washington	24.0	75.1	349.4	166.62	213.57	365.13
Total and mean	47.3	270.4	1,053.9	188.4	472.0	289.5
CANADA.	1871.	1881.	1891.	1861-71.	1871-81.	1881-91
Manitoba	25.2	62.3	154.4	.....	146.78	148.06
N. W. Territory	18.0	25.5	67.6	.....	41.75	164.76
Br. Columbia	33.6	49.5	92.8	.....	47.26	87.56
Unorganized	30.0	31.0	32.2	.....	3.10	4.00
Total and mean	106.8	168 2	345.9	.....	57.44	106.30

It will be seen that in 1871 the settlement of the Canadian northwest was much further advanced than in our strip of territories along the boundary line south of them. It had more than twice the population. Since then, in round numbers, its population has increased 240,000 or 225 per cent.,

against 2,128 per cent. in our own territories. Of this increase 178,700 was in the last decade. But that this increase has not come very largely from Ontario and Quebec will appear from the following statement:

Population of entire Canadian N. W., 1881	108,000
Natural increase of same, say 20%	33,600
Leaving for increase by emigration out of the total increase of 178,700 for 1881-91	145,100

Of the total population not home born in 1881 (58,080), 44.4% was born in Ontario and Quebec. If the same proportion still obtains the total of Ontario-Quebec emigrants in the last decade would be 64,424

This is a considerable number, which may be shown by the final figures when published to be still too small, but as even 100,000 would be only 3 per cent. of the 1881 population of Ontario and Quebec, it does not go very far to explain the very small increase of the latter's population. Had all the emigrants to the Canadian northwest from the two central provinces stayed at home, it would have increased their percentage of increase from 9.6 to only 12.0 at most.*

The growth of the Canadian northwest, in fact, is when rightly looked at one of the most disappointing features of the Canadian census. It appears to be distinctly indicated that the district is not yet felt to have any considerable attractions even for Canadian and British settlers in comparison with our own belt of states and territories immediately under the border line. How great the contrast is in the attractiveness of these two districts can be in part appreciated from the figures already given, but to fully appreciate it we must have recourse to another U. S. census bulletin (No. 63) in which state lines are disregarded and our population *between each degree of latitude* (as also longitude) given for three decades past. We abstract this as follows, beginning from the north:

	Population, 1=1,000.			1870-80	1880-90
	1870.	1880.	1890.	Per cent. incr.	
Canadian N W*	107	168	347	57 4	106.3
U. S. 48° to 49° (bd'ry)	6	17	144	183.3	747.1
" 47° to 48°	30	79	388	163.3	391.1
" 46° to 47°	84	215	547	156.0	154.4
" 45° to 46°	249	483	1,004	94.0	120.3
" 44° to 45°	1,354	1,768	2,134	30.6	20.7
Total, 44° to 49°	1,723	2,562	4,227	48.7	66.9
Canada entire*	3,687	4,325	4,829	17.3	11.7

* The Canadian figures are for a year later date than that given, viz., 1871, 1881, 1891.

It will be seen that this narrow belt between 44° and 49° now (eighteen months after the census) contains a population substantially equal to that of the Dominion. The next single degree south of it contains over three millions, and the next six and two-thirds millions, so that no more degrees could be added above. This being so, it is highly significant to note that for both of the last two decades the growth of our own population has been most rapid *immediately along the boundary line*, and has there been enormous. In the next two parallels below those listed (42°-44°) the growth for two decades has been nearly uniform at 21 per cent. The query cannot but arise, Why this sudden change at the boundary line when our own territory immediately along the boundary line is showing the strongest tendency to rapid increase of any part of our country?

But by looking on the map a probable explanation is not far to seek. The southern boundary of this belt (lat. 44° N.) cuts off a comparatively insignificant slice of our territory. Approximately speaking, the line passes just north of Portland, Me., and just south of the White Mountains, Lake Champlain, Adirondacks, and Thousand Islands. Thence it jumps to the north-central Michigan timber lands, thus cutting off an insignificant population on the east. Thence it passes through Oshkosh, Wis., southern Minnesota, the center of South Dakota, and north-center of Wyoming, to the center of Oregon. The line lies 2° north of the southern boundary which our sapient government was at one time ready to concede to Great Britain as not worth disputing over, until brought to their senses by an heroic missionary, MARCUS WHITMAN, whose lonely ride across the continent in his country's cause was as perilous and as stirring an adventure as history records.*

If, now, we imagine this little belt of country, which is about equal in area to the settled part of the Dominion, to remain as it is politically, but to be cut off from commercial intercourse with the rest of our country by a line of custom houses and customs duties, as Canada now is, there can hardly be a doubt that its population would wither away by southward emigration to more favored districts even more rapidly than the Canadian population now does, because there would be no feelings of diverse allegiance to check it. Of course, as Americans, we all believe that our own government and "institutions" are, to the extent that they differ, better than the Canadian, but the intelligent Canadian and American alike will recognize that it is not the difference in political but in industrial and commercial conditions which really causes the marked contrast in growth of population north and south of the boundary line. To the extent that the commercial follow from political conditions, no doubt, it is the price which the Canadians pay for the privilege of the British connection and independence of the United States To an unconcerned bystander the price may seem high, but then, there is no disputing about tastes. The Anglo-Saxon race is a loyal race. It does not change allegiance readily, nor seek to upset existing institutions unless and until the situation becomes desperate, and longer temporizing is plainly hopeless. May it ever be so. In that lies its strength.

We come now to the alleged disproportionate growth of city population. Ostensibly the Canadian bulletin relates only to urban population, since it is alleged to be issued while waiting for "the few remaining returns" from rural districts, but the complete returns are given in the bulletin, though the city statistics only are discussed in it. This is but natural since the increase in rural populations is almost *nil*. But we regret to be compelled to add that the discussion of the growth of urban population is not only misleading but erroneous.

The limit of urban population is fixed at 1,500 in Canada (as in England), instead of at our limit of 8,000, but there are so few towns of over 8,000 in Canada that we have summarized them separately and deduced the following abstract of urban and rural growth separately.

Population (000 omitted).	1881	1891	incr.	p c.
Urban pop'n, towns of over 8,000	653	921	268	41.04
" " " " 1,500-8,000	357	474	117	22.77
Rural population	3,315	3,435	120	3.63
Total	4,325	4,829	505	11.66

The proportion of the *total* population living in cities has varied as follows in recent years in the United States and Canada:

	1870	1880	1890
U. S. p. c. in cities of over 8,000	20.9	22.6	29.1
Canada " " " " " "	....	14.6	19.1
" " " " " "	....	23.4	42.9

The percentage of increase in city population compares as follows:

	1840-50	1850-60	1860-70	1870-80	1880-90
U. S. (over 8,000)	99 4	75.1	59.2	40.3	61 1
Canada (over 30,000)†	....	....	18.0	25.9†	52 6†
" (over 8,000)	....	....	....	....	41.0
" (over 1,500)	....	....	....	....	38 1

It will be seen that there has been a very decided recent increment in the absolute rate of increase of Canadian cities, doubtless chiefly due to the change in its fiscal policy within the last decade. But not content with bringing out this fact, as he legitimately might, the Canadian statistician proceeds to make the following comforting but (as respects the italicized clauses) amazingly untruthful comparative statements:

In comparison with the growth of city population in other countries Canada's urban development shows favorably. The 28 large cities of England increased their population during the decennium by 942,497 souls, equal to 11.2%. London increased 10.4% [etc.]. The increase in the 1,006 urban districts of England amounted to 15.3%.

The larger growths in India were [10.87% to 46.6%].

In the United States the limit of urban population is placed at 8,000 souls. *The highest percentages of increase (excluding two or three cities which had no existence in 1880 are: Chicago, 118.6%: Minneapolis, 251.4%; St. Pauls (sic), 221.1%; Kansas City, 137.9%.*

It will be seen in the tables given below that Winnipeg [25,282 pop.] shows an increase of 221.1%, New Westminster [6,641 pop.] 342.9%, and Toronto [181,220 pop.] 88.4%.

Here a direct comparison is made between three Canadian cities, two of them very small, and four American cities, whose percentage of increase is falsely stated to be "the highest" in the United States, "excluding two or three [in fact, *five*] cities which had no existence in 1880." So far is this comparison from being true that the U. S. Census bulletin is blistered all over with cities having a larger percentage of increase than the smallest of those mentioned (118.6), there being not less than 67 of them aggregating a population of 1,248,000; while there are not less than *thirty* cities, aggregating 761,788 inhabitants, and situated in 17 different states, which had a higher percentage than the *highest* of those mentioned (251.4), the average percentage of increase of those 30 cities being not less than 366 per cent. As a matter of general interest we subjoin a detail list of these 30 cities.*

In addition to the preceding there are the following 5 cities, which had no reported population in 1880: Roanoke, Va., 16,159; Superior, Wis., 11,983; Ashland, Mich., 9,956; Iron Mountain, 8,593; South Omaha, Neb., 8,062; a total of 54,759.

That these misstatements were not entirely accidental seems to be indicated by those specific comparisons which follow, and especially by the following, with which the bulletin closes:

	1880.	1890.	Incr.	In p.c
Spokane Falls, Wash.	350	19,922	19,572	5592 00
Tacoma, Wash.	1,098	36,006	34,908	3179.23
El Paso, Tex.	736	10,338	9,602	1304.62
Seattle, Wash.	3,533	42,837	39,304	1112.18
Kansas City, Kan.	3,200	38,316	35,116	1097.38
Anniston, Ala.	942	9,876	8,934	948.41
Fresno, Cal.	1,112	10,818	9,706	872.84
Duluth, Minn.	3,483	33,115	29,632	850.76
Birmingham, Ala.	2,086	26,178	23,092	748.28
Arkansas City, Ark.	1,012	8,347	7,335	724.80
Pueblo, Col.	3,217	24,558	21,341	663.38
San Diego, Cal.	2,637	16,159	13,522	512.78
Beatrice, Neb.	2,447	13,836	11,389	465.43
Hutchinson, Kan.	1,540	8,682	7,142	463.77
Sioux City, Ia.	7,366	37,806	30,440	413.2
Wichita, Kans.	4,911	23,853	18,942	385 71
Hastings, Neb.	2,817	13,584	10,767	382.22
Sioux Falls, S. Dak.	2,164	10,177	8,013	370.29
Omaha, Neb.	30,518	140,452	109,934	360.23
Kearney, Neb.	1,783	8,07[illegible]	6,292	353.09
Los Angeles, Cal.	11,183	50,395	39,212	350.64
Lincoln, Neb.	13,003	55,154	42,151	324.16
Marinette, Wis.	2,750	11,523	8,773	319.02
Findlay, O.	4,633	18,553	13,920	300.45
Asheville, N. C.	2,616	10,235	7,619	291.25
Helena, Mont.	3,624	13,834	10,210	281.73
Steelton, Pa	3,447	9,250	6,803	278.01
Dallas, Tex.	10,358	38,067	27,709	267.54
Fort Smith, Ark.	3,099	11,311	8,212	264.99
East Portland, Ore.	2,934	10,532	7,598	258.96
Totals and mean	134,598	761,78[illegible]	627,190	366.97

* Since this article was prepared we have obtained the figures for an intermediate (1886) census of Manitoba taken under Dominion authority, which if accurate indicates a very great falling off in the rate of increase of Manitoba in the last five years, and also that we have overestimated, if anything, the probable number of Ontario-Quebec emigrants to the northwest in the last decade. The population of Manitoba stood as follows:

	1881.	1886.	1891.
Population	62,260	108,640	154,442
Increase	....	46,380	45,802
Increase per cent	....	74¼%	42%

The number of Ontario-Quebec natives in Manitoba increased during 1881-6 by 23,210, and if the proportion of such to the total increase remained about the same in 1886-91 as in 1881-86 the total number of Ontario-Quebec emigrants to Manitoba alone is not likely to have exceeded 46,000, and a little over half of the total increase in the Canadian northwest has been in Manitoba.

* The story will be found in full in the Oregon volume of the Commonwealth series, Houghton, Mifflin & Co.

† These are the 8 chief cities of Canada which we tabulated separately to extend the comparison two decades further back. The smallest of these, London, began in 1861 with 11,555, and now has 31,971.

‡ Excluding the increase between 1880 and 1890 *due to additions of territory* to cities, these two percentages become 40 3 and 36.9. For comparison with United States statistics, which do not attempt to discriminate as to these additions, the figures as given are the fairer.

* The following is a complete table of the U. S. cities of over 8,000 inhabitants which have a higher percentage of increase than the highest of those mentioned as the highest in the above quotations from the Canadian census bulletin:

The city of Vancouver has grown from nothing in 1881 to 13,685. There is but one instance of *similar* [italics ours] growth in the United States—the city of Roanoke, Va.

While it is true that there is only one precisely similar case to that of Vancouver in the U. S. census, where a city which did not exist in 1881 rose to 13,685 or over in 1891, there were 5 others substantially similar, in having risen from nothing to good-sized cities within the decade, while it is only necessary to glance at the record of Spokane Falls, Tacoma, Seattle, Duluth, Omaha and other italicized cities in the table shown to see how entirely deceptive is the spirit of this statement.

The real facts as to the comparative growth of cities may be more correctly indicated by the following brief comparison:

	U. S.	Canada.
Total No. cities of over 8,000 pop'n..	443	30
Of which, decreased in pop'n.....	9 or 2%	4 or 13.3%
" " less than 10% increase..	33 or 7.4%	8 or 26.7%
" " " " 20% " ...	82 or 17.5%	11 or 36 7%
" " over 100% increase....	96 or 21-7%	4 or 13.3%
Mean increase of all cities as above.....	61.1%	41.0%

From all the preceding it will be seen that, while the absolute growth of the Canadian city population is considerable, the attempted comparison with the growth of U. S. city population is by no means "favorable," albeit the cities of Canada, unlike the cities of the United States, have absorbed nearly all the increase of population which has occurred.

AN ELECTRIC STORAGE BATTERY CAR has been built for the Birmingham Central Tramway Co., of Birmingham, England, which has 4 slow-speed motors mounted on the axles. The car is carried on two four wheeled trucks, and has accommodation for 80 passengers.

AN IRON AND ASPHALT PAVEMENT is being laid in Fenchurch St., London, says a correspondent. Upon thin layer of cement are laid frames of strips of iron, the frames being placed diagonally across the street, with strips of indiarubber between the frames. Tar is then poured into the hollows of the frames until a thin coating of it flows over the top, and finally a wearing surface of asphalt is laid. It is said that something of the same kind was tried some years ago, but did not give satisfactory results.

PLOWING WITH DYNAMITE is suggested by Mr. D. U. SLOAN, of Atlanta, Ga. His purpose is to break up the soil to a depth of 2 or 3 ft., as is done by the expensive trenching method. His plan is to drill 1,600 holes to the acre, 2 to 3 ft. deep, and to put a small amount of explosive in each hole, and fire them by electricity or otherwise. He has tried the experiment and says it will not cost more than $25 per acre, and thoroughly breaks and pulverizes the ground.

ELECTRIC LIGHTING FOR RAILWAY CARS is said to be in use on an express train in Germany running between Berlin and Frankfort. Each car has two distinct storage batteries, and the lamps are on two distinct circuits, so that in case of accident to one circuit, or on changing the batteries, the car shall not be left entirely without light. The storage cells are especially designed to stand rough handling, and have a capacity of 200 ampère hours. Each battery supplies current to four 8-c.p. lamps for the compartments, and one 5-c.p. lamp in the lavatory. The batteries, which weigh about 672 lbs. each, are placed in boxes underneath the car floor, and can be taken out and replaced very rapidly.

MEASURING THE LENGTH OF A RAILWAY BY A SPECIES OF CYCLOMETER, for purposes of the clearing house and to establish the new railway rates, was recently tried on the Midland Ry. of England. Attached to a car was a disk revolving upon one of the rails and connected with a train of wheels and a dial in the car. The main line and several of the branch lines were thus measured in one day. The same thing practically has been done on several of the American railways. The mile posts on the entire main line and branches of the Atlantic & Great Western Ry. were set from a hand-car by connecting an improvised counter with one of the large wheels of the car.

CORRESPONDENCE.

Sharp Curves in Yard Work.

MILWAUKEE, Wis., Nov. 9, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In reply to "Engineer's" inquiry relative to limit of curves for yard work, it may be interesting to know that the Pennsylvania Railroad Co. operate a number of sidings with engines having 2 drivers of 7 ft. wheel base where the radius of the curves is 100 ft. I recall two that are even less; 1 at Vine street wharf, Philadelphia, is 65 ft. and 1 at Navy Yard (old), Philadelphia, is 80 ft.

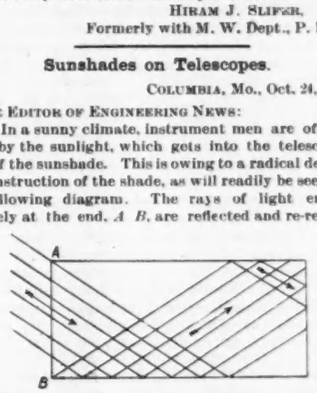
HIRAM J. SLIFER,
Formerly with M. W. Dept., P. R. R.

Sunshades on Telescopes.

COLUMBIA, Mo., Oct. 24, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

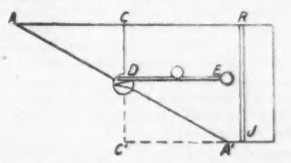
SIR: In a sunny climate, instrument men are often annoyed by the sunlight, which gets into the telescope, in spite of the sunshade. This is owing to a radical defect in the construction of the shade, as will readily be seen from the following diagram. The rays of light entering obliquely at the end, *A B*, are reflected and re-reflected



from the inner surface of the shade, until they pass through the object glass, after which the same thing is kept up until the cross-hairs are reached.

Of course a large portion of this light is absorbed by the black surface of sunshade and telescope tube; but enough reaches the cross-hairs to cause trouble.

The writer proposes to remedy the matter by cutting off



that portion of the "shade" which serves merely as a reflector, thus.

The part *A C D* may be hinged at *D* so as to turn to the position *A' C' D*, thus making the shade more convenient for packing.

The spring, *D E*, secures the hinged portion in either of the above positions.

To facilitate revolving the shade in a plane perpendicular to the optical axis of telescope, a ring joint, *R S*, is introduced. Respectfully, GORDON DINSMOOR.

Maximum Depth of Foundations by Compressed Air.

BOSTON, Mass., Nov. 7, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In to-day's ENGINEERING NEWS I see a statement by Mr. LEWIS that the maximum depth to which foundations have been carried by compressed air is 110 ft. (at the St. Louis Bridge)

At the Limfjord Bridge, near Aalborg, Denmark (1875-78), six piers were carried by compressed air to the following depths below mean stage of water:

Metres.	Ft.
34.6	113.5
33.9	111.2
34.4	112.9
34.0	111.6
34.05	111.7
34.1	111.9

Highest observed stage of water, 5 ft. above mean stage. Lowest observed stage of water, 2¼ ft. below mean stage. Ordinary variations, occurring every few days, 1¼ ft. to 1¾ ft. above and below mean stage, which amount added to above figures will represent the depth below actual stage of water. O. SONNE.

Effects of Impact on Bridges.

BOSTON, Mass., Nov. 6, 1891.

TO THE EDITOR OF ENGINEERING NEWS.

SIR: Can you or any of your readers refer me to any reports of experiments made to ascertain the amount of, and proper allowance for impact on railroad bridges? Or, failing of that, can you refer me to any papers on the subject, based on the intelligent opinion of any able engineers? K.

[Prof. S. W. ROBINSON has made the most extensive observations of this kind that we know of. See "Trans. Am. Soc. C. E.," vols. xv., xvi., xx. Mr. JAS. L. RANDOLPH also read a paper on the same subject before the same society (vol. iii.), and many more or less fragmentary discussions of the effect of vibrations are scattered through the columns of this journal and engineering literature generally. It still remains true, however, that the proper allowance to be made for vibration in proportioning bridges, or in investigating the merits of different designs, is very imperfectly known. One reason for this doubtless is that the injurious effects of vibration only become known after years of service, and *possibly* not then. "After us, the deluge."—ED. ENG. NEWS.]

Elevators in School Buildings.

BOSTON, MASS., Nov. 6, 1891.

TO THE EDITOR OF ENGINEERING NEWS.

SIR: In the ENGINEERING NEWS of Oct. 31 is an editorial upon the action of the Board of Education in Philadelphia, with regard to elevators in school buildings.

You give an opinion that this will be the first case of the use of elevators in school buildings. While this may be the case if only public schools are considered, yet it is not so if all schools are considered, for Mount Holyoke College (for young ladies), at South Hadley, Mass., has had an elevator in use for several years. W.

[In this connection it may be said that in the later discussion of the elevator question in the Philadelphia schools, close estimates show that it would require 1½ hours to take an entire school to the class room by the use of 3 elevators. The discussion has practically been dropped.—ED. ENG. NEWS.]

A Trigonometric Suggestion.

ASTORIA, Ore., Nov. 2, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I send you a method of solving an oblique angled triangle, when two sides and the included angle are given. I have not seen this in a text-book, though I believe it effects a saving in time, beside being more simple than the usual formula, which an ordinary mortal has to learn anew each time he wishes to use it. The solution is as follows:

Given the sides *c*, *b*, and the included angle *A* to find the remaining *a* side, and the remaining angles *B* and *C*.

From either of the unknown angles draw a perpendicular to the opposite side. In the figure [omitted because readily sketched.—ED.], *Be* is made perpendicular to *b*.

Then we have at once

$$A\,e = c \sin A$$
$$B\,e = c \cos A$$
$$e\,C = b - Ae$$
$$\frac{B\,e}{e\,C} = \tan C$$

Or, in other words, solve *Be A* and *Be C* as right angled triangles. The formulas for this purpose are always in memory, and the process itself seems to involve less computation. C. F. LESTER.

[We agree with our correspondent that this is often, if not always, the simpler way of solving a single triangle with two sides and the included angle given.—ED. ENG. NEWS.]

Wooden Water Supply Conduits.

ENGINEER'S OFFICE, TORONTO WATER-WORKS,
TORONTO, CAN., Nov. 6, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In your issue of Oct. 24 last I read the communication of Mr. VAN AUKEN concerning wooden conduits, and as I have had the opportunity of gaining some information concerning the same I take pleasure in sending it, such as it is.

The water-works of Ottawa, Canada, laid a 30-in. wooden conduit in 1874 under the surface of the Ottawa River, and it was thought under such conditions 2-in. pine staves would outlast the iron bands, but on the contrary the staves have failed. On examination, during 1889, the staves were found to be worn away or eaten down to a thickness of 1½ ins., and also, where the edges of the staves came together numerous holes, varying in length from 4 ins. to 6 ins. by 1 in. wide, penetrated the pipe.

These defects were supposed to be due in part to the decaying of the surface of the wood by the chemical action of the river water; and in part to the breaking up and removal of this decayed surface by aquatic insects, who dig into it for shelter and for food, so as to constantly expose a new surface of the wood to the action of the water.

Mr. JAMES FLETCHER, Entomologist at the Government Central Experimental Farm, also partially accounts for this decaying as on account of the quantity of air that must necessarily be in the Ottawa River after passing down the Deschenes Rapids. Oak slats, which have only been down ten years, taken from the same works, are in a much worse condition than the pine staves.

As for the wooden conduit of the Toronto Water-Works, Canada, built in 1877, and only just now abandoned (1891),

nothing can as yet be definitely stated as to the cause of its failure, as no thorough examination has been made. It was constructed of alternate oak and pine staves 3 × 6 ins., bound with iron straps 3 × ¼ ins., spaced 2 ft. apart. It has proved to be very leaky and unfit for use.

I am in hopes that circumstances will soon enable me to make a close examination of the pipes, and when I do so I will gladly furnish you with the results.

WALTER C. BROUGH,
A. M. Can. Soc. C. E.

The Late Cattle Guards Tests—Correction.

CHICAGO, Nov. 3, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: Our attention has just been called to a contributed article in your issue of Oct. 24 (p. 389), entitled "Some Cattle Guards Which Failed to Guard," that is so unjust to us, and so wide of the facts, that it would seem to us that the person who wrote it could not have been present at the test, or had deliberately misrepresented the matter for reasons of a personal nature.

This company had only one guard in track at the test referred to, and it was the last guard crossed of those tested, including the pit guard, which was made with chamfered crossties and a pit 40 ins. deep. The guard described as the sewer pipe guard was not shown

We mail under separate cover a copy of the *Indianapolis Journal* of Oct. 14, in which is given on page 6 a fair and impartial report of the cattle guard test made at Brightwood, Ind. The person who wrote this article was invited to be present at the test by the "Big Four" officials, and was unknown to any of the members of this company who were present until after the article referred to was written. We have since learned that it was submitted to some of the officials who were present prior to its publication, and was approved by them as an impartial statement of what occurred during the test made.

If these are facts, you will of course admit that the article in your issue of Oct. 24 is very unfair to us, and we seriously regret its publication. The test demonstrated what we have always claimed to be the truth, that *no* cattle guard known to man is a positive stop, but that the improved National Surface Guard came nearer filling all requirements than any other known device.

J. T. HALL, Manager.

[The report published came to us from an official source, and we are confident was intended to be an absolutely fair statement of the facts. To make sure of this, however, we wrote for further details, which we hope to be able to present shortly. In the meantime we give the substance of the newspaper report referred to above. The discrepancy between the two statements is merely that the one objected to put the order in which the cattle guards last crossed were crossed as National, Bush and (only after all the surface guards were gated) the pit guard, whereas our correspondent above and the *Indianapolis Journal* claim that the order was Bush, Kalamazoo, pit and National. This is a question of fact. There should be no possibility of dispute about it.—ED. ENG. NEWS].

[*Condensed from Indianapolis Journal, Oct.* 14, 1891.]

The surface guards now on the market, namely, the National, the Kalamazoo, the Seymour, the Short Hill and the Bush, were placed side by side, together with the standard pit-guard. Twenty cows which had been collected were placed on one side and very inviting piles of green cornstalks on the other, to tempt the cattle to cross these guards. For five minutes the cattle gave the several guards a good looking over. When one ventured to cross the Seymour guard caught its foot, and it was two or three minutes in releasing itself; the animal then crossed over to the side on which was the green corn. Two others then crossed the Bush guard, after which gates were put up at both the Seymour and Bush guards. Two cows then crossed, with but little trouble, the Kalamazoo guard. A gate was then put up at that guard. For several minutes the cattle hesitated about crossing either of the remaining guards. Finally one crossed the Short Hill guard. The interest among the railroad men then became intense, there being only the National guard, the pet guard of engineers of maintenance of way, and the standard pit guard left to cross. The cattle which had crossed the other guards were driven around to the inclosure with the other cattle. Fresh corn-stalks were placed on the other side of both guards, and soon a cow gave a jump over the pit guard, struggled in it for a little time, and sprung over to the side on which the corn lay. Shortly, to even up things, seemingly, a cow made a break and crossed the National guard. A second then crossed the pit guard, and another over the National guard The friends of the latter seemed satisfied with the test, as the National guard was the last one crossed. But the test demonstrated that the guard which would prevent tramp cattle crossing had yet to be invented, and that of the surface guards so far tested, the National came the nearest accomplishing this object. While there was a division of opinion as to which of the guards—the pit or the surface—was the best preventive of cattle-crossing, it was conceded by all that yesterday the National guard was the most effective of the surface guards.

The test yesterday, in some respects, was made under unfavorable conditions, such as are not likely to occur on the main lines of railways. Among those who witnessed the tests all were disposed to give each a fair trial. While some who witnessed the test were disappointed that the cattle would cross either of the surface guards, they admitted that a long stride had been made toward a desirable surface guard. The National guard consists of parallel steel slats, 4 ins. apart, saw-teeth on top of slat, short steel barbs thrown out from sides of slats to inflict sufficient punishment to turn stock. The depth of the pit-guard was 40 ins., which would be a depth hardly practicable on a majority of roads.

Irrigation in Eastern Washington.

NORTH YAKIMA, Wash., Oct. 23, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: The Northern Pacific, North Yakima & Kittitas Irrigation Co. is a company gotten up by some of the officials of the Northern Pacific R. R. Mr. PAUL SCHULZE, of Tacoma, is President of the irrigation company, and he assures me that there is no connection between the railway and the irrigation company. It is a fact, however, that employees of the irrigation company are given transportation by the Northern Pacific R. R. Co., and that supplies for the irrigation company are hauled by the railway company at construction rates.

The canal of the Northern Pacific, North Yakima & Kittitas Irrigation Co. takes water from the Yakima River, some 10 miles below the rapidly growing city of North Yakima. The head works consist of a low concrete dam with butterfly weirs, arranged to fall at high water and to divert some 450 cu. ft. of water per second into the company's canal at all times when irrigating may be in progress. The canal is designed to be about 60 miles long, and about 30 miles are actually being built. The cross-section is 30 ft. on the bottom, slopes 2 to 1 inside, 1½ to 1 outside, berm 6 ft. wide, bank 8 ft. high. All excavated material is used to strengthen the banks and none is wasted. The cut is 20% in excess of fill. The grade is 3 ft. in 10,000, and the estimated depth of water is 6 ft. The material passed through is generally a fine volcanic soil, exceedingly rich when watered, but so fine and dusty as to be very difficult to handle. The lateral system for this canal has not yet begun. There is some talk of introducing wrought iron pipe, as the slope of the land from the canal toward the Yakima River is in many places too steep for the economical use of ditches. The 65 miles of canal are designed to cover 60,000 acres and a second canal of the same section, but of greater length, is being considered to water another 60,000 acres lying above the present work. This second or "High Line Canal," if built, will be one of the boldest irrigation enterprises in the Pacific Northwest, as it must cross the Yakima River in an inverted siphon at Union Gap, after passing through several miles of flume. C. R. ROCKWOOD, C. E., is the Engineer, and he has made several important changes in the original and slightly defective design of WM. HAM. HALL, the company's first Consulting Engineer. In connection with the canal will be a series of natural storage reservoirs, supplemented by timber-crib dams in the headwaters of the Yakima and Nachess Rivers.

The Cowiche and Wide Hollow Valleys are considering a scheme of irrigation to be developed under the "Wright Irrigation Law." Mr. GUY STERLING is their Engineer.

The Selah Valley ditch again shows signs of activity, and is designed to cover a tract of very fertile country.

The most novel scheme for Washington, although common enough in California, is that of the Yakima Land Co., embracing 10,000 acres of the upper Moxee Valley. Four years ago the first attempt was made to raise money for an artesian well, but not enough was raised to justify the experiment. Last November some of the original promoters of the scheme looked the ground over again, and recognizing its extreme fertility and the growing scarcity of irrigable lands, called for an expert report on the probability of finding artesian water in a country believed to be volcanic in its formation. The report was favorable and work was begun at once. One well has been sunk into a stratum of water-bearing sandstone and it yields through a 6-in. pipe a flow of 1.13 cu. ft. per second. A second well, 10 ins. in diameter, is just entering what seems to be the same stratum. This discovery of water-bearing sandstone in the high lands of eastern Washington, with its attendant circumstances of freedom from malaria and typhoid fever is one of the greatest advances made in the last few years in that rapidly growing state. Extensive tracts of land in the vicinity of the Yakima Land Co.'s holdings have been bought or bonded and active work on them will soon begin. SAMUEL STORROW, C. E., is the engineer for the Yakima Land Co,

Still another irrigation company, as yet in an embryo state, has just been started. They are said to control a strip along the Columbia River containing 15,000 acres. H. V. GATES, late of the Union Pacific Ry. Co., is their engineer, and he proposes to use as much of the flow of the Yakima River as the Northern Pacific, North Yakima & Kaittitas Irrigation Co. may leave in that stream.

SAMUEL STORROW, Engineer Yakima Land Co.

Concerning the Late Blockade in the St. Mary River.

SAULT STE. MARIE, Mich., Nov. 4, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: So much anxiety having been felt during the recent blockade (by the wreck of the *Peck* of the channel of Lake George in St. Mary River) for an early clearance for the passage of vessels, and so much criticism having been made afterward, of the action of the officials in making an entirely new channel around the wreck, and the time consumed in doing it, I thought it an act of simple justice to the public, who have a right to know, and to the officials whose acts have been criticised, to give a resident version of the case.

The *Susan E. Peck* was sunk Oct. 10 at 10 minutes after 1 o'clock P. M. in and across the channel in Lake George, a shallow lake in St. Mary River. The accident occurred in the natural channel, which is about 3,600 ft. in length, connected at each end by a dredged channel with deep water. The dredging of these cuts was done more than 20 years ago, and no appropriation has been made within 10 years for improving them. The stern of the *Peck* was stranded in about 3 ft. of water, while the bow was submerged in 20 ft. The first intelligence of the disaster was received by the officials at the Engineer's office at the Sault about 4 o'clock P. M. through Dunbar's telephone. The General Superintendent, E. S. WHEELER, immediately telegraphed General POE, and received in reply the following dispatch about 7 P. M.: "Employ enough dredges by the hour at best possible terms. Work day and night to open channel in shortest time." At 7.30 P. M. Gen. Supt. WHEELER had completed arrangements with Messrs. Dunbar & Sullivan, the Government contractors at the Neebish, the lower entrance of Hay Lake, for four dredges at $12 per hour. They were prepared Saturday night and started for the wreck at daylight Sunday. Three of them were at work at 11 A. M. Sunday. The fourth reached the wreck at night. Gen. Supt. WHEELER, Engineer JOSEPH RIPLEY and Mr. MICHAEL SULLIVAN, of the firm of Dunbar & Sullivan, reached the wreck at 8 A. M. Sunday. An examination showed the water around the stern of the wreck to be 3 ft. in depth and 20 ft. at the bow. It was therefore decided to dredge the channel around the bow of the wreck. As fast as the plant arrived it was placed in position by Mr. SULLIVAN, who remained in charge of the wreck night and day until the channel was opened. It was completed at 3 o'clock P. M. the following Thursday, being four days and four hours from the time work was commenced 12,000 cu. yds. of earth were removed.

As the dredges had completed their work and were preparing to move off, the wrecking tug appeared. Prior to the completion on Wednesday Superintendent LYNCH with two assistants from the canal visited all the waiting vessels, took their time, and arranged the order of passing the wreck. This was done after consultation with and the approval of the majority of the waiting captains. It was arranged that they should go through in lots of ten. Two tugs were used as dispatch boats, one above and one below. While one lot of ten were passing, another lot of ten were notified of their turn. The great majority of the captains patiently waited their turn, and gave all possible assistance in maintaining order. The waiting vessels were all passed by noon of Wednesday, Oct. 21. Two hundred and seventy-five vessels in all were delayed more or less. There were no collisions or accidents of any moment. The wreck was raised and swung out of the way on Saturday Oct. 24, two weeks after she was sunk.

A careful consideration of the facts shows that Gen. Supt. WHEELER under authority from Gen. POE proceeded expeditiously with the most available means at his command to relieve the blockade of waiting vessels, fast gathering, and passed them without material accident, speedily and in order. No vessel was allowed undue advantage over another, and, if one did pass out of turn through the cut, it was not allowed to be the gainer by any earlier lockage through the Ship Canal. This systematized control of the passage of vessels was necessary to an early clearance of the blockade and the prevention of accidents. The situation was unique. The General Superintendent had no control over or authority for the immediate removal of the wreck. If power had been vested in Gen. POE, it is believed that by the employment of wrecking apparatus owned here, the *Peck* could have been removed in less time than the new channel was dredged. That the law does not give authority to Gen. POE to speedily clear of wrecks the narrow channels of the connecting waters of the lakes, but requires 30 days' notice "to all persons interested in such vessel or craft" to do so, seems to be a defect which should be remedied. The law gives the right of removal of wrecks to the General Superintendent, under the direction of the Secretary of War, in the St. Mary's Falls Canal as it is strictly an artificial channel constructed by the Government. The same control of all wrecks obstructing navigation should be vested over all the narrows of the connecting waters of the lakes in the interest of commerce.

Genl. Supt. WHEELER and his corps of assistants used all possible efforts to clear the blockade and expedite the passage of vessels. This was their plain duty and it was outside of such duty for the officials to take measures to protect the wreck by driving piles around its bow or otherwise as has been suggested in one of the criticisms. The protection and removal of the wreck was the immediate duty of the owners or persons interested. That the channel was cut and the dredges were leaving when the men and tug arrived for the repair and removal of the wreck shows the promptness of Gen. POE and his assistants. The accident and blockade is an object lesson showing the great necessity for the speedy completion of the Hay Lake improvements and the widening and deepening of the shallows of the connecting waters of the lakes between Duluth, Chicago and Buffalo. The improved Hay Lake channel will give another route of passage

shorten the distance 11 miles and avoid most of the narrows and shallows of the St. Mary River between the Sault and Lake Huron.

Fortunately Congress has appropriated sufficient money for the completion of this work. Thirteen dredges are now at work, owned by energetic contractors, and a larger number will be operated next season. The contract time for the completion expires with the year 1893. The same contract date is fixed for the construction of the walls of the new lock in the St. Mary's Falls Canal. No doubt exists as to the ability of the contractors, Messrs. Hughes Bros. & Bangs, to finish their work at the stipulated time. Their plant has never been equaled on any similar contract here. The coffer dam for the protection of the work appears to be sufficient and permanent, and a small pump working a few hours each day easily disposes of all leakage. It is to be hoped that the deepening and widening of the canal and its approaches will be speedily commenced, so that when the massive gates of the new lock shall swing in position the monster carriers of our inland commerce will not scrape upon the bottom in their entrance or exit.

It may not be amiss for one who as a member of the Legislature of Michigan formulated the bill and as chairman of the Committee of Federal Relations urged its passage for the transfer of the St. Mary's Falls Canal to the United States, who as a member of the Fiftieth Congress aided in the passage of the largest single appropriation ever made for this work; and who as a member of three committees appointed by as many different waterway conventions to memorialize Congress, and as chairman of the last of such committees drafted and urged the insertion of a paragraph in the River and Harbor Bill, for a survey and estimate of cost of a deep water channel through the shallows of the connecting waters of the lakes, between Duluth, Chicago and Buffalo; to venture the assertion that Gen. POE and his able assistant, Genl. Supt. E. S. WHEELER, will supplement the appropriations of Congress with such wise and comprehensive plans as will make the improvements of St. Mary River, the delight of navigators, the pride of the lakes, and the new lock, the largest, most complete, and best equipped in the world; and it is to be hoped nothing will prevent the work being done speedily.

HENRY W. SEYMOUR.

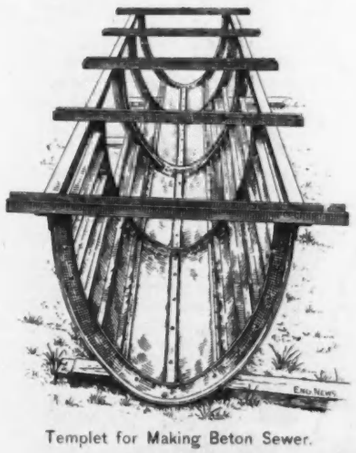
Templets for Beton Sewers.

NEWPORT, R. I., Oct. 28, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: Noticing the inquiry of A. C. C. concerning concrete and beton sewers, published in your issue of Oct. 17, we beg to submit the following account of the construction of the main sewer at Middlesborough, Ky., which is oval in shape, with a vertical diameter of four feet, and which was built of beton, tamped behind movable sectional steel templets.

Each of these templets is a little over 10 ft. long, and is formed, first, of a frame made of three U-shaped ribs of T iron, placed parallel (one rib at each end and one in the



Templet for Making Beton Sewer.

middle of the 10-ft. section), fastened together at the top by two longitudinal angle irons riveted to the outside of the T-irons, one at each side of the U. These ribs are further connected by a floor of two pieces of sheet steel (placed end to end, with the rib of the center T between), each piece 5 ft. long and 22 ins. wide, curved to form troughs corresponding with the bottom of the U curve of the ribs. Each trough is riveted at each end to the T-iron upon which it rests.

Across the legs of each U is riveted a channel bar, 4½ ft. long, thus, ⊔, which rests upon the concrete backing of the sewer (described below) and supports the templet in place. This constitutes the frame.

The sides are of movable pieces of channel iron, 5 ft. long each, placed ten on each side in five rows, and secured, when in use, by sliding bolts (one to each piece) which, when thrown, will pass through the rib of the U-shaped T-iron, and project sufficiently on its other side to securely hold the corresponding piece in the adjoining section. These movable side pieces are interchangeable.

These templets were used in pairs, and their operation was as follows: After the ditch had been dug and the bottom roughly filled and shaped with broken stone and mortar, forming the concrete backing above referred to, the empty frame of the templet was lowered into the ditch until suspended by the cross beams. Then the space between the bottom of the ditch (or the concrete backing) and the sheet steel floor of the frame was filled with beton (damp, not wet) and rammed until thoroughly compacted. Then one of the movable side pieces was bolted into the frame on each side, and the space behind this was filled with beton and rammed. When full another side piece was bolted on, and more beton filled behind, and so on until all the channels were in place and the wall of the sewer built to the proper height, when the work was left to set while another templet, adjoining the first, was placed in the ditch, and the process repeated there. By this time the portion of sewer first built had set, and the movable sides were unbolted and taken out, the frame removed to a point lower down the ditch, where the operation was repeated. When the sewer invert had sufficiently hardened, the top was built by first plastering a center with not less than one inch of mortar, made of one part of cement to two of sand. Concrete was placed on this, inside of wooden templets, before it set, to a thickness of about six inches, and the key between the templet frames, which ran on each side to within about 9 inches of the center, was roughly plastered with coarse mortar.

The labor and materials used were as follows, figures given being for 100 ft. of length.

Bottom concrete:	
Cement	18.5 bbls.
Sand	2.7 yds.
Broken stone	15 yds.
Labor	17 days
Bottom lining tamped behind iron templets:	
Cement	25.25 bbls.
Sand	7.5 yds.
Labor	22 days
Sewer top:	
Cement	26 bbls.
Sand	3.9 yds.
Broken stone	13.6 yds.
Labor	21 days

At the prices for brick masonry in Middlesborough the saving in cost was about 25%, while the results are much more satisfactory. Concerning smaller sewers of cement pipe, we beg to refer to data furnished by our company upon application. The templets above described are patented, and the rights are owned by this company.

WARING SEWER PIPE CO.,
G. EVERETT HILL, Secy.

The Richmond & Danville Bridge Disaster.

ATLANTA, Ga., Nov. 9, 1891.

TO THE EDITORS OF ENGINEERING NEWS:

SIR: I note in your issue of Nov. 7 you have an account of our bridge accident at Danville, signed S. H. LEA. I do not understand how Mr. LEA could have gotten the information he sends you.

The accident was caused by a collision on the bridge of a freight train running into the rear end of a shifting train. The engine of the shifting train was not thrown into the river as he states, but the engine of the freight train, a heavy consolidation engine, was, with three cars of the shifting train, and I do not understand how he found out that the members of the truss on the west side were unbroken and on the east side broken. Those on the east side were at the bottom of the river, with the engine and cars on top of them, and those on the west side lying on top of the engine and cars, as the engine fell to the east side. As well as we could determine, the freight engine running under the cars, lifted them up until they struck the top chord and twisted them around so as to give the greatest shock to the east upper chord.

I see in your editorial notice of this accident that you have stated it practically correctly

CHANNING M. BOLTON, Chief Engineer.

The Automatic Coupler Hearing.

The Committee of State Railroad Commissioners appointed at the late convention of commissioners to consider and report what national legislation, if any, was desirable to hasten the introduction of train safety appliances, more particularly automatic couplers and train brakes, gave a hearing in this city on Tuesday, Nov. 10, as previously announced in this journal. The members of the committee present were: Commissioners Geo. C. Crocker (Mass.), chairman, Spencer Smith (Ia.), Wm. E. Rogers (N. Y.), and John H. King (S. Dak.). Commissioner Jas. C. Hill (Va.) was unable to be present. Secretary Edward A. Moseley, of the Interstate Commerce Commission, acted as Secretary. A large number of prominent railway men were present, including T. N. Ely (Penns.), G. W. Rhodes (C. B. & Q.), H. S. Haines (Plant system), E. B. Thomas (Erie), R. C. Blackall (D. & H. C. Co.), L. Tuttle (N. Y., N. H. & H.), E. D. T. Myers (R. F. & P.), Hon. L. S. Coffin, ex-commissioner of Iowa, and representing the Order of Railway Conductors and Brotherhood of Railway Trainmen, Wm. McWood (Grand Trunk), Wm. G. Rice (Consol. Car Heating Co.), J. T. Chamberlain (B. & M.), C. A. Hammond, Secy, Am. Soc. Ry. Supts., A. D. Shaw, Third Auditor U. S. Treasury, representing the Yardmasters' Association, and many others.

Remarks were made in the forenoon by Col. Haines, Mr. Blackhall, Mr. Ely, Mr. Thomas, Mr. Bradley, and Mr. M. N. Forney, who spoke in behalf of the Master Mechanics' Association. The general tenor of all these remarks was that no compulsory legislation was needed to stimulate the railway companies to greater activity in procuring improved appliances for brakes and couplers. The representative of each road explained that his particular road was equipping its cars with air brakes and improved vertical-plane couplers as rapidly as possible. Vice-President Thomas of the Erie, said that of the 995 engines owned by that road 66% now have the air brake equipment, and at least 18% of the freight cars are equipped with the M. C. B. coupler.

The statement was also made that the American Railway Association, which represents about 125,000 out of the 160,000 miles of railroads in this country, had passed a resolution favoring a vertical-plane, automatic coupler.

The afternoon session was almost entirely consumed by representatives of the yard switchmen, who did not mince words in denouncing the present state of affairs. Why they might consistently do so, keeping in view only the present situation, and yet might be entirely mistaken in their representations, is shown in another column. Mr. Frank Sweeny, Grand Master of the Switchmen's Mutual Aid Society, said that the great variety of "draft irons," as he called them, were an imposition on the switchmen. By introducing so many different kinds of couplers the railways have made the duties of the switchmen extra hazardous. If there was only one kind of coupler, the number of fatalities among switchmen would be lessened materially. Mr. Sweeny said that if he had all of the cars in the country absolutely under his control he would equip them all with the old link and pin. A national convention of switchmen held last year adopted a resolution favoring the link and pin. Another member of the switchmen's fraternity said that the new fashioned couplers were continually getting out of order. He preferred the link and pin.

Mr. John A. Hall, of the Supreme Council of the United Order of Railroad Employees, explained the duties of a yard switchman, and argued for uniformity in the types of couplers and uniformity in the height of freight cars. He thought the railway companies should be assisted by legislation in hastening the time when the car couplers will be uniform. He believed in the link and pin himself, but was willing to accept any one of the improved types providing all the roads used that one.

Mr. A. D. Shaw spoke earnestly in favor of a single type of coupler. There were too many kinds of couplers now in use, and there should be legislation to stop the present state of affairs. Remarks of a similar tenor were made by Mr. William McWood, of the Grand Trunk; the Hon. L. S. Coffin, of Iowa; J. T. Chamberlain, of the Boston & Maine Road, and Samuel Heberling, a Duluth switchman. Mr. G. W. Rhodes, of the C., B. & Q., told of the efforts that road had made to get the best car equipment possible, and urged that compulsory legislation might tend to make us a "Chinese" nation by checking the progress of improvement.

Secretary Moseley presented the following as the result of his inquiries by circular of the railway companies of the country:

Total no. locomotives reported			27,159
Of which, with driving wheel brakes			17,000
Total no. of freight cars reported			978,161
Of which equipped with Janney		40,231	
" " " Gould		23,357	
" " " Henson		42,061	
" " " "M. C. B."		13,279	
Total equipped with M. C. B. couplers		118,928	
" " " other aut.	"	10,376	129,307
Leaving as link and pin or its equivalent			848,854
Of these there were, Safford form of drawhead			12,207
And other "specified" couplers			38,955
Total no. cars equipped with Westinghouse brakes			97,238
" " " " Eames	"		30
" " " " Boyden	"		304
" " " " other types of	"		12,555
Total no. cars equipped with any train brake			110,127

[These figures as to cars equipped with train brakes certainly err by omission, as we think do also those as to couplers, but in much less degree. In our issue of May 2, 1891, we published a detail table compiled from direct reports from the several companies, in which 102,390 cars were shown to be equipped with train brakes on (or about) Jan. 1, 1891. Our preceding issue (May 25, 1891) showed in like way and with like detail, that 102,347 cars were then equipped with M. C. B. couplers.]

The replies to the question regarding the best means of

bringing about uniformity in safety car couplers are not at all clear in many cases, but the following statement has been prepared showing as nearly as possible the position of the roads:

	Roads.	Miles.
Favoring national legislation	69	13,014
" voluntary action	88	46,791
" State legislation	2	139
" M. C. B. type	17	11,915
" various couplers	10	4,829
" delay on ground that the question is still experimental	15	9,447
Expressing no opinion as to best means of bringing about uniformity in automatic couplers	145	38,985
Whole number and mileage represented	346	125,120

The committee held an executive session next day to consider the testimony.

Suspension Cableway at Austin Dam.

In our issue of July 11, 1891, we published an account of the construction of the great Austin dam at Austin, Tex., giving plans and details of this structure.

One of the most noticeable features of this work is the suspension cableway used to transport waste material from excavation to banks, and stone and cement from banks to the work. This plant, which is said to be the largest of its kind in the world, was designed by Mr. SPENCER MILLER, Mechanical Engineer, of the Lidgerwood Mfg. Co., of this city.

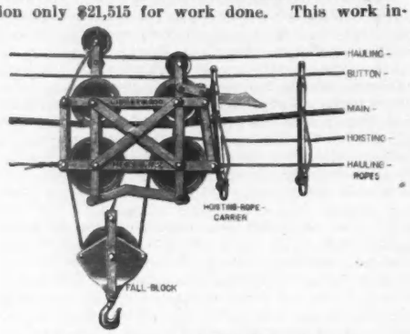
It is constructed under the Locke-Miller patents. The main cable, with a span of 1,350 ft., is 2½ ins. in diameter, and the hoisting and endless ropes are ¾ in., all of crucible steel.

The hoisting engine is a special Lidgerwood having two patent friction drums. One is grooved for ¾-in. hoisting rope, the other is turned with a curved face to operate the endless rope and is called the winch drum.

The cable carriage and fall rope carriers were new, and while designed especially for this plant are now the standard for all Locke-Miller cableways the company produces. Fall rope or hoisting rope carriers are absolutel y indispensable in a plant over 200 ft. long, and this company have really solved the problem perfectly satisfactorily.

In operation, the carriage in moving away from the engine carries on a horn (projecting in front of carriage) all the fall rope carriers. A series of buttons, growing larger as they recede from the engine, are mounted upon a ⅛-in. rope called the button rope. These buttons correspond in size to a series of slots in the heads of the fall rope carriers. The smallest button passes through all the carriers except the last, which it takes off the horn, depositing the same on the main cable, where it serves as a support to the hoisting rope. The second button takes off the next carrier and so on. In returning the horns on the cable carriage pick up all these carriers.

The capacity of this plant is 7 tons, which may be carried the whole distance stated in about 1½ minutes. The contractor, Mr. BERNARD CORRIGAN, is perfectly satisfied with the plant. The cost of handling material is about 4 to 5 c. per ton.



Cable Carriage and Fall Rope Carrier.

The Liverpool Water-Works Tunnel.

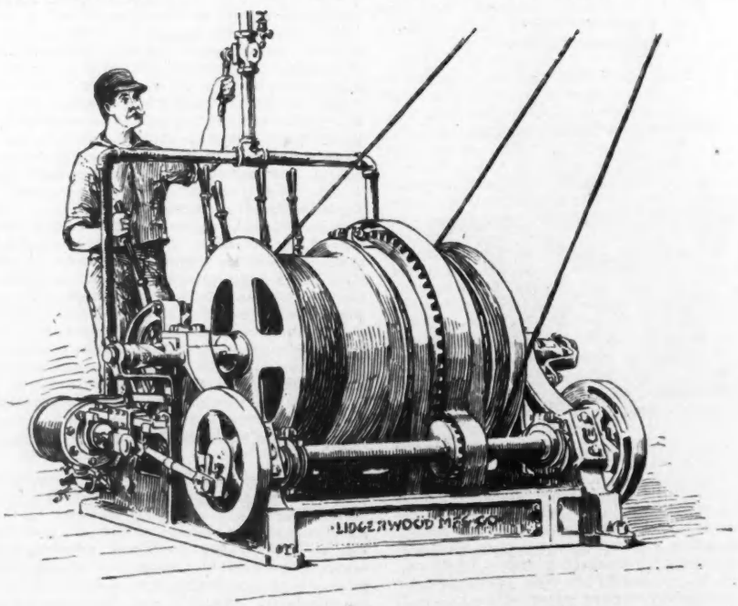
The Liverpool water-works tunnel under the Mersey River is still giving trouble. As before mentioned in this journal, the contract was taken from the original contractors, Messrs. Monk & Newell, by reason of non-compliance with the terms of the contract. John Cochrane & Sons then undertook to complete the tunnel shafts and lay the pipe for the sum of $60,000 plus the cost of such castings and iron work as might be found necessary, or about $20,000 more. Very lately Mr. JOHN COCHRANE committed suicide after the firm of which he was the head had expended a total of $91,140 on the plant and work and had received from the corporation only $21,515 for work done. This work included one shaft and 185 ft. of tunnel. The Cheshire shaft is now down to the required depth and the work remaining includes the completion of these shafts and the driving and lining of 620 ft. of tunnel.

The Water Committee of the Corporation has now made a new arrangement with the last firm whereby the contractor assigns over to the Corporation the retained percentage of $5,375, the deposit of $7,500 now in the hands of the Corporation, and all the plant now on the work in which the contractor has an interest. The Corporation will practically do the work itself, retaining the men now on the work, and places these men under "the constant supervision" of Mr. ARTHUR COCHRANE, of the late firm, who is to receive $25 per week toward his personal expenses as long as he resides near the works. The work is under the direction of Mr. GEORGE F. DEACON, the Engineer of the Liverpool Corporation.

Sir BENJAMIN BAKER, who was lately called in as Consulting Engineer, has made a detailed report to the Corporation, in which he says that the engineering troubles present are greatly due to the lack of uniformity in the material encountered, and in this respect the tunnel is without precedent. But he says these difficulties are not insurmountable, and that the past great delays are chiefly due to the several contractors underrating the difficulties and in failing to provide sufficient plant. Though the borings showed clay with occasional gravel, the original contractors laid out the work for clay only and failed. The second contractor, with this experience before him, provided a shield which might have worked well in sand or fine gravel alone, but was not adapted to the mixture of materials known to exist. In their case it may be said, however, that they were attempting something never done before. Sir BENJAMIN recommends the repair and modification of the present shield, and to at once design another shield of an efficient character, so that it may be on hand if the other fails. He recommended the offer of premiums for quicker work to the men, and, in this connection, mentioned that at the Sarnia tunnel a practical suggestion made by a workman had increased the rate of progress 50%. This device and the incidents connected with its introduction are fully described in ENGINEERING NEWS of Dec. 27, 1890.

At the same meeting of the Corporation Mr. GEORGE F. DEACON again called attention to the fact that this tunnel was none of his planning but was forced upon the Corporation by the action of the Board of Trade in refusing to allow pipes to be submerged in a trench dug in the river bed, except under prohibitive conditions.

SUSPENSION CABLEWAY AT AUSTIN DAM, AUSTIN, TEX.



VIEW OF LIDGERWOOD HOISTING ENGINE.

Test of Hollow Arch-blocks.

We are indebted to Mr. W. E. Cutshaw, City Engineer of Richmond, Va., for the following tests made by him of hollow arch-blocks made by the Empire Fire Proofing Co., of Empire, O., and Pittsburgh, Pa.:

TESTS OF THE EMPIRE CO.'S HOLLOW ARCH BLOCKS LAID IN ROSENDALE CEMENT AND SAND MORTAR MIXED 1 TO 2.

1ST TEST.—6-IN. BLOCKS BURNED TO A DARK COLOR.

Total load, lbs.	Load, pr. sq. ft., lbs.	Deflection.	Clear span, 3.95 ft.	Loaded area, 9.25 sq. ft.	Set one week before loading.
		in.			
2,695	291.3	1/8	Slight crack in cement joint underneath at center.		
4,410	476.7	3/8			
5,551	600.1	5/8			

2D TEST.—6 IN. BLOCKS BURNED TO A LIGHT COLOR.

Total load, lbs.	Load per sq. ft., lbs.	Deflection.	Clear span, 3.95 ft.	Loaded area, 9.25 sq. ft.	Set one week before loading.
		In.			
980	105.9	1/32			
2,205	238.4	1/8			
3,675	397.3	3/16	Beams spread 1/2 in. at bottom.		
4,900	529.7	1/2			
5,355	579.	.....	Arch collapsed.		

3D TEST—6-IN. BLOCKS BURNED TO A LIGHT COLOR.

Total load lbs.	Load per sq. ft., lbs.	Deflection.	Clear span, 3.95 ft.	Loaded area, 9.39 sq. ft.	Set one week before loading.
		In.	Slight crack in cement joint underneath at center.		Cambered 1/4 inch.
980	104 4	0			
1,470	156.5	1/16			
2,205	234.8	1/4			
			Top flanges of beams approached each other 1/16 in.		
3,675	391.4	1/16			
4,613	491.3	.....	Arch collapsed.		

4TH TEST.—6 IN. BLOCKS BURNED TO A LIGHT COLOR.

Total load, lbs.	Load per sq. ft., lbs.	Deflection.	Clear span, 3.95 ft.	Loaded area, 9.36 sq. ft.	Set 36 h'rs before loading.
		In.			
735	78.5	1/16	Slight crack in cement joint underneath at center.		
1,225	130.9	1/8			
1,715	183.2	3/16			
1,960	209.4	1/16			
2,450	261.5	1/4			
2,695	288	.....	Arch broken.		

5TH TEST.—6-IN. BLOCKS BURNED TO A LIGHT COLOR.

Total load, lbs.	Load per sq. ft., lbs.	Deflection.	Clear span, 3.47 ft.	Loaded area, 8.81 sq. ft.	Set 24 hours before loading.
		In.			Cambered 3/8 in.
735	83.4	1/16			
1,225	139.	1/8			
1,715	196.	3/16			
2,205	251.6	1/4			
3,241	367.9	.....	Arch broken.		

6TH TEST.—12-IN. BLOCKS BURNED TO A DARK COLOR.

Total load, lbs.	Load per sq. ft., lbs.	Deflection.	Clear span, 3.74 ft.	Loaded area, 8.23 sq. ft.	Set 40 days before loading.
		in.			
980	125	1/16			
1,782	236	1/8			
3,089	408	1/16			
5,352	708	1/4			
5,352	708	1/4	After interval of 1 hour.		
5,572	736	3/8	Stood 48 hours.		
7,603	1,005	1/2	Left loaded for 8 days no further deflection.		

7TH TEST.—12-IN. ARCH BURNED TO A LIGHT COLOR.

Total load, lbs.	Load per sq. ft, lbs.	Deflection.	Clear span, 3.74 ft.	Loaded area, 8.23 sq. ft.	Set 40 days before loading.
		In.			
4,752	576	1/16	Deflection increased to 3/8 in. in 24 hours.		
5,950	720	1/10			
6,415	778	.....	Collapsed in 4 hours.		

8TH TEST—12-IN. ARCH BURNED TO A VERY LIGHT COLOR

Total oad. Lbs.	Load, per sq. ft. Lbs.	Deflection.	Clear span, 4.37 ft.	Loaded area, 11.4 sq. ft	Set 20 days before loading.
		In.			
3,168	277	1/16	Crack in cement joint at key.		
4,752	415.5	1/8			
6,336	554	.....	Collapsed in 24 hours.		

9TH TEST—12-IN. ARCH BURNED TO A LIGHT COLOR.

Total load. Lbs.	Load per sq. ft. Lbs.	Deflection.	Clear span, 4.37 ft.	Loaded area, 11.45 sq. ft	Set 20 d'ys before loading.
		Ins.			
3,168	277.	0			
4,752	415.5	1/8			
8,579	749.	1/4	Left on 48 hours.		
10,144	888	1/16	Left on 48 hours		
11,412	1,000	.....	Collapsed.		

10TH TEST.—12-IN. ARCH BURNED TO A LIGHT COLOR.

Total load. Lbs.	Load per sq. ft. Lbs.	Deflection.	Clear span, 4.33 ft.	Loaded area, 11.34 sq. ft	Set 37 d'ys before loading.
		In.			
1,180.8	102	0			
1,771.2	153	1/16			
2,066.4	178.5	1/16	Slight crack in cement joint, 1st block next skew, back.		
2,656.8	229.5	1/8			
2,952	255	.....	Slight crack in joint at key.		
3,542.4	306	3/16			
4,428	382.5	1/4			
5,904	510	1/4	Crack in key joint increased.		
6,494.4	561	1/4	Stood with load 15 hrs.		
7,084.8	612.2	1/8	Arch broken suddenly.		

11TH TEST.—12-IN. ARCH BURNED TO A DARK COLOR.

Total load. Lbs.	Load per sq. ft. Lbs.	Deflection.	Clear span, 4.33 ft.	Loaded area, 16.83 sq. ft	Set 10 d'ys before loading.
		In.			
4,717	4o6	1/32			
7,637	705	1/8			
8,212	758	1/16			
9,509	878	1/10	Crack in cement joint 2d block from skewback.		
9,701	896	3/8			
11,445	1,057	.....	Arch collapsed.		

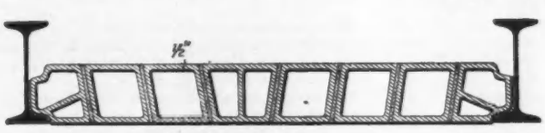
12TH TEST.—12-IN. ARCH BURNED TO DARK COLOR.

Total load. Lbs.	Load per sq. ft. Lbs.	Deflection.	Clear span, 4.33 ft.	Loaded area, 11.00 sq. ft	Set 19 d'ys before loading.
		In.			
3 599	327	1/8			
6,442	586	1/8			
8,442	768	.....	Collapsed.		

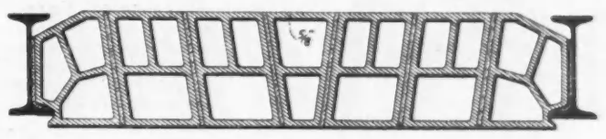
13TH TEST.—12-IN ARCH BURNED TO A DARK COLOR.

Total load. Lbs.	Load per sq. ft. Lbs.	Deflection.	Clear span 4.33 ft.	Loaded area, 11.00 sq. ft	Set 23 d'ys before loading.
		In.			
2.868	261	1/16			
6,910	628	1/8			
8.204	746	1/16			
9.013	819	1/4			
9,860	896	1/8			
10,434	949	..	Collapsed.		

The arches were carefully laid on rigid flat centers between I beams securely bolted together, and with joints of about 1/8 in., using shims of same material as arch blocks, where necessary to make close surfaces; and after standing till the mortar had set, a thin uniform layer of sand was spread over the arches, the center removed and bricks placed on in regular courses till the arches broke. Tests No. 1 and 6 had reached prescribed limits of 600 and 1,000 lbs. per sq. ft. without breaking, and were taken down. The loads of test 12 were made up of both bricks and pig iron, and of tests 11 and 13 of pig iron alone, with 1 1/2 in. planks laid on the sand bed. These tests ran through a period of about 7 months from Nov. 15, 1890, to June 24, 1891.



Single Arch.



Double Arch.

HOLLOW ARCH BLOCKS: Empire Fireproofing Co.

The Nickel Mines of New Caledonia.

The following is from a report by U. S. Vice-Commercial Agent LE MESCAM, of Nouméa:

The area of New Caledonia is 772,000 sq. miles, and it includes about 308,800 sq. miles of nickel-producing land. About 30,880 sq. miles have already been granted to, or applied for by various mining companies, but about 7,720 sq. miles of the land are being actually worked, principally in districts easily reached by sea or rivers. Some of the best claims are not yet worked on account of the difficulties resulting from the absence of roads.

The composition of the nickel ore is hydrated silicate of nickel and magnesia, without any traces of arsenic. It contains from 8% to 10% of metal, some samples containing up to 16% of pure nickel. The value of 8% ore at shipping places is $19.03 per ton, but the price will probably augment. The mines are reported to be inexhaustible.

Ships can load at several other ports on each of the coasts of the colony, but foreign vessels have to pay coasting duties of $37.50 per registered ton at any other port than Nouméa. The exportation of ore from New Caledonia during the year 1890 has been: Nickel ore, 5,000 tons; chromate of iron, 1,506 tons; cobalt, 700 tons; gold quartz, 10 tons; and of smaller metals—nickel, 1.50 tons; silver lead, 3.50 tons; copper, 1.32 tons

The exportation will greatly augment henceforth, for large orders have been received by the Compagnie le Nickel for ore and metal. The Creusot factories of France alone have ordered 100,000 tons of nickel ore.

Important foundries and furnaces are now being erected in the vicinity of Nouméa for the treatment of nickel ore, and the prospects seem to indicate that at a date not far off this colony will greatly surpass any country in the world in richness and importance of the nickel industry.

Deep Shaft Sinking.

In a paper read before the British Association at Cardiff Mr. HENRY D. AVERY, M.I. C. E., described a method of sinking shafts through water bearing strata. In the ordinary plan of doing this work a sump is kept in advance of the full shaft and the difficulty to be met with is in the sinking of this sump. He proposes to locate the pump in a bore-hole made before the shaft is commenced.

The chief novelty is in adapting the pump to this service and the prevention of rubbish from passing down the hole and choking the pump. He provides against the latter by a heavy taper shield of cast steel surrounding the pump and resting on the edge of the bore-hole. This shield is perforated with holes to allow the water to pass down, but so arranged as to exclude débris. This shield is very heavy and it follows the excavation around the pump and protects the latter from injury in blasting.

The pump is made without a foot valve, the rod of the bucket working through the seating of a valve which rests on top of the working barrel. By this arrangement the drawing of the bucket also draws the valve; and should the bottom of the bore hole be filled by sand this can be removed by lowering a scoop such as is used in making bore holes. The bore hole is supposed to be sunk deep enough to provide a place for this sand below the pump. He recommends duplicate pumping engines and bore holes. These holes would be 30 ins. in diameter, but he does not describe his plan for sinking them.

The Weldon Range Finder.

Col. WELDON, of the British army, has considerably improved his ingenious range finder, and this improvement is thus described in *Engineering:*

It consists of a metal box, the lid of which is shown open in the engraving, and on this lid are fitted three prisms which are the essential constituents of the instrument. When the lid is closed these, with the compass and level, also attached to the lid, lie inside the metal box, and are thus thoroughly protected. The upper prism marked 1 is a right-angled one, and is mounted with the right angle outward; looking into the left hand corner of this prism one will see in it, by double reflection, objects lying on one's right hand. Below this is a second prism with a principal angle of 88° 51′ 15″ and below this a third with a principal angle of 74° 53′ 15″. A level and a compass are also mounted on the lid as shown. To use the instrument the observer stands so that the object the range of which is required lies on his right hand, and looking into the left-hand corner of the upper prism views it there by double reflection from the internal faces of the prism. At the same time looking through the opening shown in

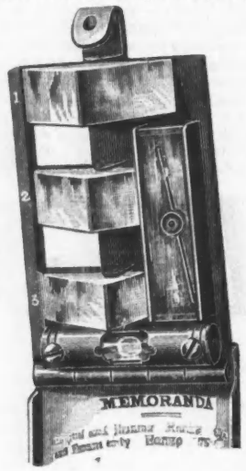


Fig. 1.—The Weldon Range Finder.

the lid below the prism he selects some object, which appears nearly in line with the image seen in the prism. He then shifts his position till these two images coincide, in which case lines joining him with the two objects will make right angles with each other. In Fig. 2, *O* is the object whose range is required, *D* the object seen by direct vision, and *A* the position of the observer. The observer now marks his position on the ground, and shifting the instrument looks into the left-hand corner of the second prism, when he again sees the image of the object, whose range is required, by double reflection, but lying now to the right of the object *D*. He then retires, keeping in line with *A* and *D*, till he reaches *B*, when the two images again coincide, the lines joining them, and the observer now makes an angle of 88° 51′ 15″ Then in the triangle $\hat{O}\ B\ A$, $O\ A = \tan 88° 51' 15'' \times A\ B = 50\ A\ B$. The length $A\ B$ is easily paced, and the distance $O\ A$ is 50 times this length.

Fig. 1.

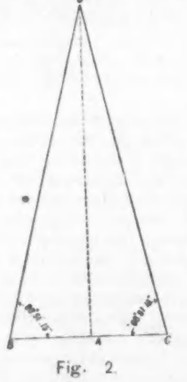


Fig. 2.

A longer base, and probably greater accuracy, can be obtained by using the second prism only, as indicated in Fig. 3, in which case the distance of the object is 25 times the distance *B C*. This second prism is, however, best adapted for predicting the range of moving objects. Three observers are required. Two of them have finders, while the other measures the distance between the two. The first two observers separate, and No. 2 takes a position such that the object is reflected to one side of observer No. 1, whom he views by direct vision. As the object continues to move its image gets nearer and nearer No. 1, who during the whole of the time moves a little to one side or the other, so as to keep the image of the object constantly in line with No. 2. Just as the image of the object gets very near No. 1, No. 2 calls out "Ready," the distance between the two observers is taken by the third, and when the image of the object actually falls on No. 1 its distance is just 25 times the distance between them, and the guns set to this range are fired by word of command from No. 2. By using the third prism in conjunction with the second a still longer base of one-fourth the distance of the object can be employed. The range finder can also be used as a depleidoscope for transit observations. For this purpose it is mounted on a block of wood by means of an elastic band and levelled by the level on its lid being at the same time set in the meridian of the place. The lid is opened to make an angle with the horizon equal to the latitude of the place of observation. On looking into the upper prism two images of the sun will be seen on each side of the apex of the prism, which gradually approach each other as the sun nears the meridian, and finally coincide as it passes it, the time of which being noted gives the longitude of the place.

Extensive trials of the instrument have been made both in this country and in India, which agree in showing that the average error in using the instruments is about 2½ to 3½%. Col. Weldon's address is Earlimount, Early near Reading.

Typhoid Fever and Water Supplies.

Mr. HIRAM F. MILLS, C. E., member of the Massachusetts State Board of Health, contributes a paper upon typhoid fever in its relation to water supplies. He says that the highest death-rates by typhoid fever in Massachusetts are not in the cities but in towns drawing water from wells. The five towns highest on the list, for the past 18 years, have an average death-rate of 12.82 per 10,000; while the five cities having the highest death-rate by typhoid fever, in the past 12 years, average 7.65 per 10,000, and the average for all the cities in the State for the same time is 4.62.

The town of Ware had the highest death-rate from typhoid, or 16.5 per 10,000, in 1886. In this year the town introduced a water supply, and though this water is not yet generally used the rate has fallen to 6.9. Newburyport used well water until 1881, when water was brought from springs. In the 9 years previous to 1881, the deaths yearly from typhoid were 4.55 per 10,000. In 7 years the rate has been reduced to 2.07.

Mr. MILLS says that typhoid is to a great extent a preventable disease. Twenty-five years ago the average number of deaths by typhoid fever was 7.8 per 10,000 in Massachusetts; the present yearly rate is 4.6. But industrial towns and cities still suffer. The case of Lowell, Lawrence and Holyoke is mentioned at length in this report. For the 12 months ending April 1, 1891, Lowell, with 78,000 inhabitants, had 150 deaths from typhoid, and Lawrence, with 45,000, had 78 deaths. The actual number of deaths in all the cities in the state from this desease is now about 600 per year. Careful study of the situation was made in these two cities, and the probable cause in Lowell was to traced the contamination of the water supply by fœces of typhoid patients discharged into Stony Brook, only 3 miles up-stream from the intake to the water supply. This discharge was followed in a few weeks by a very rapid increase in the number of deaths by typhoid fever in Lowell. In December typhoid fever germs were found in the Lawrence water supply.

An examination of the bad conditions at Holyoke, Mass., also proved that one of the main sewers of that city emptied into the river a short distance above the entrance to the upper canal. Nearly all the sewage from the factories entered the canals directly, and the water used for drinking in the factories came from three sources, viz.: the public water supply, which has very little chance of being contaminated; water from the canals, either direct or passed through rapid filters; and from wells in the factory yards, which last water came directly from the canals. The well water was more commonly used in summer, being cooler. A comparison of the death rate by typhoid fever in Holyoke, among people of different occupations, showed that the rate among those employed in the mills was more than three times as great as among all other persons. It should be said here that the average yearly deaths from typhoid fever in the three cities that head the list in Massachusetts are, for the years 1878 to 1889: Holyoke, 8.93 per 10,000; Lawrence, 8.33, and Lowell, 7.63, for the same number. In the cases of Lawrence and Lowell the conclusion is reached that the excess of typhoid in Lawrence follows from and is due to the existence of the disease in Lowell, and the latter city receives the disease from towns up the river which discharge sewage into this river.

To test the effect of temperature in the Merrimack River on typhoid fever germs, in the month of November the Board of Health instituted a series of experiments. They inoculated water from the service pipes with typhoid fever germs and kept the water in a bottle surrounded by ice, at as near freezing as possible for one month. Each day they took out 1 cu. c. m. and determined the number of typhoid germs. The result was as follows:

First	day	there	were	6,120	germs.
Fifth	"	"	"	3,100	"
Tenth	"	"	"	490	"
Fifteenth	"	"	"	100	"
Twentieth	"	"	"	17	"
Twenty-fifth	"	"	"	0	"

This experiment indicated that typhoid germs from the Lowell sewers may live long enough in winter to enter the Lawrence reservoir in large numbers; that the number will decrease in the reservoirs, but a considerable fraction live to enter the service pipes.

Effect of Temperature on the Strength of Railway Axles.*—III.

The present paper contains the concluding experiments of the author's research "On the Effect of Temperature on the Strength of Railway Axles." [For the prior paper see ENG. NEWS, Feb. 18, 25, 1888.—ED.]

The experiments now described, which form Set V., relate to the influence of temperature on the resistance to concussion of railway axles, when submitted to a recurring impact energy of 5 ft.-tons. It may be remarked that in the prior observations the impact energy was in part 10 ft.-tons at each blow, and in part only 2½ ft.-tons for each blow. The method adopted in the present part of the investigation was generally the same as that formerly described. To preserve uniformity for purposes of comparison, the 29 "best best" fagoted scrap railway axles used were in every respect similar, both as regards material and manipulation, to those employed for the former observations. They were made at the Wortley Iron Works, near Sheffield, and were of the following dimensions:

	Ft.	Ins.
Total length of axle (c. to c. of journals, 6 ft. 6 in.)	7	3½
Length of wheel seats	0	10⅝
Length of journals (end collars, 1 in.)	0	7½
Diameter of middle	0	4½
Diameter of wheel seats and end of collars	0	5⅛ full
Diameter of journals	0	3¾

Each pair of axles (*i. e.*, one for the warm tests and the other for the cold tests) was made from the two halves of the same fagot, so as to have a uniform and homogeneous structure for purposes of comparison.

For convenience the experiments are divided into Set V., Cold Tests, and Set V., Warm Tests; the former showing the influence of a temperature of 0° Fahr. on the impact resistance of axles, and the latter that of a temperature of 100° Fahr. under similar conditions.

Set V.—Cold Tests.—Eighteen axles were tested in this set of experiments. They were allowed to cool gradually to their temperature of normal rigidity, viz., the atmospheric temperature at the time they were made, 44° to 54° Fahr. They were then buried separately in a heap of about 30 tons of snow for periods 12 to 26 days. At the end of that time each axle was removed and placed in a cooling cage, which was surrounded with a large quantity of a freezing mixture, composed of 2 parts snow and 1 part (by weight) of salt, for 13 hours, or until the metal had acquired the temperature of 0° Fahr. It was then removed and placed on the impact testing apparatus on bearings 3 ft. 6 ins. apart, and received one blow on the centre from a tup weighing 1 ton and falling 5 ft. The extent of the deflection between the bearings was carefully taken, and the axle put back in the freezing mixture for 15 minutes; it was afterward placed on the bearings half turned over, and again tested in the manner described by the falling weight. It was always replaced in the freezing mixture for 15 minutes after each blow, so as to make sure of its being kept at a temperature of 0° Fahr. throughout the tests, and the operation was repeated until fracture occurred, with the results recorded in Table I.

Set V.—Warm Tests.—Eleven axles were tested in this set in the following manner, for comparison with the Cold Tests of Set V.: After forging they were allowed gradually to cool to the temperature of normal rigidity, and were placed in a large water bath, which was gradually raised to 100° Fahr. Each axle was then removed to the

* A paper by Mr. THOMAS ANDREWS, M. Inst. C. E., before the Institution of Civil Engineers.

impact testing apparatus and immediately tested in the manner above described.

Between the blows each axle was half turned over, and was also replaced for 15 minutes in the water bath. The deflections between the bearings were carefully measured after each impact, and the extent of the distortion from the original circular form of the axles, arising from the continued concussion, is also given where necessary. The results of this series of observations are recorded in Table II.

The mean force of concussion resulting from each impact was ascertained as follows:

h = height of free fall in feet, } thus $h\ w = W$ = "energy."
w = weight of test ball, } or work in foots-tons.
x = extent of deflections between bearings,

$$\text{then F (mean force)} = \frac{W}{x} = \frac{h\ w}{x}.$$

The results of these experiments show that whereas at a temperature of 0° Fahr., a total average mean force of 179,670 tons was sufficient to cause the breaking of the axles, at a temperature of 100° Fahr. a total average mean force of 428,333 tons was requisite to produce fracture. In other words, the resistance to concussion of the axles at a temperature of 0° Fahr., was only about 42% of what it was at a temperature of 100° Fahr.—[Italics ours.—ED.]

TABLE 1.—COLD TESTS. 0° FAHR.

Axle No.	No. blows.	Total deflection, ins.	Ft. tons of impact.	Accumulated energy, ft. tons.
102	9	12⅛	325.5	40
104	2	1¼	49.0	5
105	4	4 11/16	119.3	15
106	4	4 3/16	132.7	15
107	4	4⅜	127.1	15
109	5	5⅝	168.9	20
110	9	12 1/16	328.1	40
112	8	10⅝	284.4	35
114	4	4 3/16	134.7	15
115	6	22	630.4	75
116	4	4¼	117.8	15
117	4	4⅜	120.6	15
118	2	1⅝	44.6	5
119	3	2 13/16	88.4	10
122	5	6 1/16	157.0	20
123	4	4¾	117.8	15
127	3	2 15/16	84.6	10
128	6	7⅝	202.8	25
	5⅛	6.48	179.7	21.67

TABLE 2.—WARM TESTS. 100° FAHR.

Axle No.	No. blows.	Total deflection, ins.	Ft. tons of impact.	Accumulated energy, ft. tons.
124	8	10⅛	289.9	35
125	9	11 13/16	339.7	40
126	5	6⅜	154.8	20
129	11	15⅞	405.3	50
130	19	25⅞	728.6	90
131	15	20⅞	583.0	70
132	12	17¼	434.5	55
133	13	17⅝	513.8	60
134	3	3 9/16	69.4	10
135	18	23 1/16	780.8	85
136	10	14	357.8	45
	11.2	15.06	428.3	50.9

NOTE.—These tables are given in much more detail in the paper, giving each blow separately.

The average total deflection at a temperature of 0° Fahr. was 6.48 in., as against 15.06 in. with the axles at 100° Fahr. under the conditions stated; this represents an ultimate reduction of flexibility, under the test of impact, of about 57% for the cold axles at 0° Fahr., compared with the warm axles at 100° Fahr.

Mr. HERBERT TOMLINSON, F. R. S.,* has demonstrated that repeated change of temperature alone, even with in the comparatvely moderate range from 100° C. to 17° C., produces a considerable amount of internal friction between the constituent molecules of the metal, which tends to modify some of its physical properties. He has shown that the electrical resistance and magnetic properties, etc., are influenced by repeated heating and cooling of the metal. He observes that "some of the physical properties of iron wire, even if it has been previously well annealed, can be considerably modified by repeatedly raising the metal to the temperature of 100° C. and suffering it to cool again. The internal friction, for instance, of a torsionally oscillating iron wire can be largely and permanently reduced by this process." " . . . The cooling exerts an influence as well as the heating."

GENERAL SUMMARY OF RESULTS.

The constant internal friction produced by frequent alternations of temperature, apart from the jars and concussions of wear and tear, tends in course of time to alter to some extent the properties of iron and steel axles. Steel being more sensitive to this influence than wrought iron, becomes more liable to alteration of its physical properties, and to this cause may probably be traced the greater proportion of breakages of steel axles occurring in countries such as India and Canada, where variations of temperature are extreme.* In these and other lands railway axles are exposed to the influence of periodic climatic changes of temperature, and often to considerable diurnal variations. Axles also become brittle and crystalline, as the result of the frequent heavy concussions of wear and tear. Mr. G. SNELUS, F. R. S., has recently remarked, "that the intricate changes in the condition of iron were extremely interesting, but were very difficult to follow. There was one condition of masses which he thought they had overlooked in those changes, viz., the crystalline condition of matter. Any one who had ever seen a broken railway axle, and the very large facets that there were in the iron, which no doubt at one time was fibrous, would know, that vibration had an enormous effect in producing crystallization."

The author undertook this research in order to determine by experiments on a large scale the resistance of metals to sudden concussion at varying temperatures down to 0° Fahr., and at the same time to ascertain, if possible, some of the causes leading to accidental fractures on railways. The investigation has extended over nearly seven years, and the results obtained have from time to time been published in the Proceedings of the "Institution" Vols. lxxxvii., xciv., ciii.

It may be desirable in conclusion to give a brief résumé of the whole series of observations made in connection with the research. The following are the author's general tentative conclusions:

1. The impact tests with an energy of 10 ft.-tons on axle at a temperature of 212° Fahr., compared with results at 7° Fahr., indicated an increase of endurance at the higher temperature of about 235%.

2. The impact tests with an energy of 15 ft.-tons on axles at a temperature 120° Fahr., compared with results at 7° Fahr., showed an increase of endurance at the higher temperature of nearly 120%.

3. The impact tests with an energy of 10 ft.-tons on axles examined at a temperature of 100° Fahr., when contrasted with results obtained at 7° Fahr., demonstrated an increase of resistance at the higher temperature of about 43%, and this increase was, within certain limits, in proportion to the increase of temperature.

4. The impact tests with an energy of 5 ft.-tons on axles at a temperature of 100° Fahr. gave an increase of resistance of about 138%, compared with the results on axles similarly tested, but at a temperature of 0° Fahr.

5. The impact experiments with an energy of 2½ ft.-tons, applied to axles at a temperature of 100° F., compared with experiments at 0° F., showed an increased resisting power to concussion at the higher temperature of nearly 88%.

The author has also found that when axles were subjected to a number of heavy blows the extent of the deflection was more during the earlier blows under some temperature conditions than the deflections produced by the later blows, *i. e.*, the elastic limit of the axles had risen. This progressive decrease of deflection was manifest with the impacts made at the temperatures of 212° F., 120 F. and 100° F., but it was not observable when the axles were at a temperature of 0° F.

The experiments on the "Effect of Chilling on the Impact Resistance of Metals" (Proc. Inst. C. E., vol. ciii., p. 231) were of a different nature, and are, consequently, scarcely comparable with the above results. Among other things, however, they showed that a reduction of the impact resistance of metals results from even a single lowering of the temperature through 100° F., more extensive chilling producing considerable reduction of resistance to impact.

In the course of the research allusion has been made to alternating changes of temperature in axles owing to journal friction and the effect of this in inducing fracture. It has also been indicated that repeated concussions increase the rigidity of both steel and iron axles, and tend to induce brittleness in the metal.

Careful determinations with delicate apparatus have also been made of the heat dilatations of railway axles at varying temperatures from 0°, 100°, 212°, 392°, and 572° Fahr., and the detailed results have been given in the former parts of this paper. It was observed that large forgings, such as railway axles, expanded somewhat unequally in different directions owing to the diversified molecular structure of the forged metal. It was ascertained that wrought iron axles generally show premonitory signs of destruction previous to final fracture, whereas steel ones appear to break suddenly without previous warning.

Full-sized photographs of most of the 286 fractures have been taken so as to preserve accurate records of the comparative aspects of fractures occurring at different temperatures.

The appearance of the fractures of the warm tests was found to be of a fibrous character, those of the cold tests having a more fine-grained and crystalline aspect. [See ENG. NEWS, Feb. 18, 25, 1888, for illustrations].

It will be observed that the different sets of experiments were made under varied conditions both of temperature and force of impact, etc., which probably accounts for the somewhat diversified comparative percentages obtained. The results of each set are, however, comparable with themselves.

The author's conclusions receive confirmation from the recent experiments made in Sweden by Mr. C. P. SANDBERG, Assoc. M. Inst. C. E., showing the effect of low temperature on the strength of wrought iron and steel rails. Mr. SANDBERG found that the resistance of steel rails to impact was considerably reduced at low temperatures, and this is also in accord with the author's experience.

[The author also mentions a considerable list of confirmatory evidence, most of which is already known to careful readers of this journal.—ED.]

Some idea of the difficulties and extent of the investigation is afforded when it is stated that a total number of about 286 railway axles and forgings, weighing 41 tons 16 cwt., have been tested and destroyed in the various experiments, and about 273 tons of snow, ice and salt have been used for the freezing mixtures required.

* Philosophical Magazine, Vol. xxix., p. 77.

* See the remarks on the failure of steel axles in India, by Sir ALEXANDER M. RENDEL, K. C. I. E., M. A., M. Inst. C. E., in *The Engineer*, Sept. 19, 1890, p. 235, and reference may also be made to the recent failures of steel axles on the Canadian Pacific Railway.

Census Transportation Statistics. New England and Middle States.

Census Bulletin No. 115 is devoted to railway transportation statistics of the Middle States (Group II.), in which are included Maryland and part of Pennsylvania. From this and from the corresponding bulletin for the New England States (No. 46), which we have not heretofore abstracted, some interesting facts can be deduced, these bulletins having the special advantage that they give throughout (barring some minor exceptions) a direct comparison between 1880 and 1889, the growth during which period, we need hardly say, was phenomenally great, even in the eastern sections of the country.

One of the most startling and gratifying facts which can be deduced from the returns is not given at all in the bulletins, viz., the increase in freight trainloads. This we have computed to be as follows (by dividing the total ton mileage by the total freight train mileage):

Av. tons per train.	New England.	Middle.
1880	80	178
1881	90	179
1882	96	186
1883	96	192
1884	100	193
1885	103	203
1886	104	210
1887	112	214
1888	114	210
1889	114	223
Increase 1880–1889, tons	34	45
" " " per cent	42.5%	25.3%

The difference in the operating conditions accounts for the great difference in average train load between the two sections, but the increase in each is equally gratifying and significant.

Passenger trainloads, on the contrary, have in each section remained nearly constant, the number of trains being increased about as fast as the traffic grows. The record, as we have computed it, stands as follows:

Av. passengers per train.	New England.	Middle.
1880	54	45
1881	56	48
1882	59	51½
1883	58½	49
1884	59	46¼
1885	58½	46
1886	60	45¾
1887	62	46
1888	59½	45½
1889	60¼	47

With these records of the changes in the work done per train, it is interesting to contrast the changes in the rates charged to the public.

RECEIPTS PER MILE FROM FREIGHT AND PASSENGERS.

	New England.		Middle.	
Freight and Passenger Receipts per mile.	Per ton mile.	Per passenger mile.	Per ton mile.	Per passenger mile (*a*).
	Cents.	Cents.	Cents.	Cents.
1880	1.842	2.188	1.044	2.252
1881	1.722	2.116	0.984	2.130
1882	1.728	2.076	0.982	2.097
1883	1.728	2.079	0.998	2.141
1884	1.647	2.016	0.914	2.004
1885	1.576	1.966	0.804	1.875
1886	1.589	1.960	0.819	2.001
1887	1.587	1.930	0.827	2.041
1888	1.527	1.956	0.816	1.985
1889	1.470	1.920	0.808	1.995
Decr. per ct.	19.8%	12.2%	22.3%	10.6%

a Deduct 11% from passenger earnings for mail and express.

It will be seen that almost the whole of the saving effected by the increase in train load has been allowed to the public in the form of lower rates. We say "almost the whole" for the reason that a saving of 50% in number of trains means a saving of only 25% in total operating expenses, and proportionately for other earnings. It is not surprising that the growth of trainloads should be rapid in the Middle States, through which the great trunk lines from the Western prairies pass, but it is surprising that New England should make almost as good a showing, the conditions of New England and Old England traffic being much the same. Unfortunately corresponding records from Old England cannot be obtained and do not exist, but there can be little doubt that if such records did exist, no such growth in trainloads would be visible upon the other side.

In the Middle States, while the passenger engine

mileage has increased 91.1%, and the freight engine mileage 47.5%, the "other" mileage (chiefly switching) has increased no less than 163.35%. The "other" mileage is now no less than 38.6% of the freight train mileage against only 21.7% in 1880.

Much of this apparent increase, however, would appear to be what has been aptly called "general office mileage," since the increase in number of switch engines has been in no such proportion. In 1880 it was 25.7% of the freight engines, and in 1889 only 27.8%, an increase of no significance. The miles run per year per freight engine has remained nearly constant at 22,200; the miles per passenger engine, on the contrary, has largely increased—from 23,700 to 30,300.

In the New England states the switching engines number 40% of the freight engines, against only 26% in 1880, but then the freight engines are a far smaller proportion of total than in the Middle states. These figures, however, will serve to indicate what an enormous and increasing addition switching makes to the direct cost of transport.

The changes in number of employees, etc., per unit of work may be abstracted as follows:

Per 100 miles of road.	New England. 1889.	New England. 1889.	Middle. 1880.	Middle. 1889.
Maintenance of way	165	220	255	315
" equipt.	93	121	198	246
Conducting transp'n	282	398	426	545
General	19	22	28	32
Total	559	761	907	1,138
Ton-miles per employee	88,234	90,961	219,679	233,321
Pass. "	54,863	60,583	29,050	33,093
Ton-miles per freight engine	2,745,219	2,928,255	4,307,363	4,538,786
Ton-miles per passenger engine	1,181,716	1,545,409	1,165,704	1,430,105
Freight cars per 1,000,000 tons	1,418	1,370	1,363	1,372

The increase in work done per engine in New England is very notable. The increase in work done per employee is less notable in either section. The increase in number of freight cars per 1,000,000 tons carried is materially less than the constant agitation of this question would lead one to expect. It will be seen that in round numbers each freight car handles 700 tons of freight yearly in both the New England and Middle States. The cost of using an *extra* freight car to handle the same traffic (with the same average load per car when in motion) may be estimated at not over $40 per year, chiefly for interest. If we assume 20% of the freight car stock to be really superfluous under good management, this amounts to a waste of $8 per car per year, or a little over *one cent* for each ton handled. It makes a vast sum in the aggregate, but where is the shipper who is not cheerfully willing to pay one cent per ton for a little less strictness in regard to unloading promptly? And where is the railway which is not glad to gain the favor of its shippers at a total cost of one cent per ton, when its total average receipts per ton handled were in 1889, $1.07 in New England, and 97 cents in the Middle States? There is apt to be a reason for such apparent wastes when they are looked into, and there is no waste so trifling *comparatively* it that does not look immense absolutely when computed for such a vast railway system as our own.

The percentage of increase in traffic during this period of nine years we compute to be in round numbers as follows:

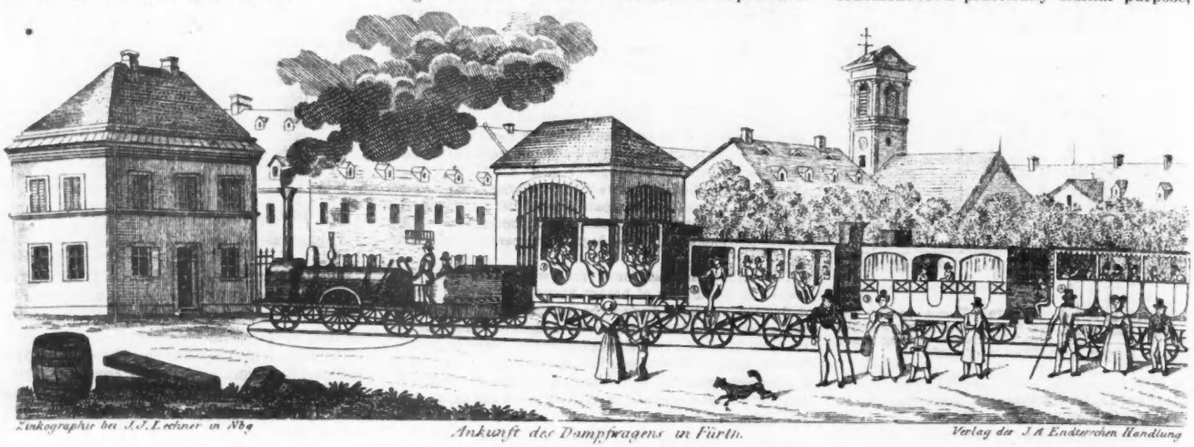
Percentage of increase, 1880-89.	New England.	Middle.
Number of passengers carried	98.0	131.3
Passenger miles	65.9	99.0
Number of tons carried	47.0	66.0
Ton-miles	77.9	83.9

That the passenger traffic has increased so much more in proportion than the freight traffic will be a surprise to many readers. It will be seen that in both sections the average haul per passenger has notably decreased, while the average haul on freight has as notably increased, both in the New England and Middle States. We compute the average hauls in 1880 and 1889, as follows:

	New England.		Middle.	
Average haul in miles.	1880	1889	1880	1889
Of passengers	16.7	15.0	20.2	17.4
Of freight	58	65½	86¼	45½

Reason enough, and to spare, why New England freight rates should be considerably higher than in the Middle States are visible in these figures of comparative haul and volume of traffic, as also why passenger rates should be substantially the same.

Some other figures of probable interest which might be deduced from these bulletins we pass over until the figures can be given for more sections, or for all together. In the meantime, we may remark in closing that, while ideas as to what figures and ratios should or should not be given will differ it appears to us that all of these given herein are of a kind to be generally useful and to be deserving of record in bulletins of this character. It is therefore with some disappointment that we have found ourselves obliged to compute most of them for ourselves from the original quantities, while others which seem to us of less general interest and value are given with much fullness. We are not prepared to say that any of these now given should be omitted, but we do think that those given in this article but not in the bulletins should be included in the latter, at least in the final summary by sections for the whole United States.



THE FIRST GERMAN RAILWAY TRAIN OF 1835.
(From an old engraving.)

Slate Channeling by Machinery.

A machine for channeling in slate has been successfully introduced into six Pennsylvania slate quarries by the Ingersoll-Sergeant Drill Co., of New York. It is a special adaptation of their bar channeler, which has been long used as a general quarrying machine in marble, limestone, sandstone, &c.

The machine carries its two 10-ft. heavy bars on four weighted legs. Upon the bars slides a Standard Ingersoll-Sergeant rock drill of special construction, with the shellpiece or guide to the cylinder having an extended end, which serves to guide the crosshead carrying the cutting tools. A feed screw running the length of the bars and parallel to them moves the drill by means of a special three-cylinder engine. The direction of motion is reversed automatically when the cutting engine reaches either end of the bars.

A round hole is drilled at either end, and the channeling is then done up to this hole. It will make a vertical or horizontal cut, and also can be adjusted for an inclined quarry floor. The owners of the Pen Argyle and Bangor Slate quarries, in Pennsylvania, fare cutting from 60 to 100 lin. ft. per day of channels with this machine. And the foreman of the first-named quarry says he has saved, in three months, 30,000 sq. ft. of rock, as compared with the old process of mining, a saving which covers the cost of the machine.

The First German Railway Train of 1835.

Railway construction in Germany was inaugurated by the building of a line between Nuremberg and Fürth, which was opened in 1835. The development of the system was slow, however, as in 1840 there were but 291 miles in operation. The accompanying cut, found among a lot of old prints, shows the arrival of this first train at Fürth, and it is given to our readers as a curious reminder of the earlier railways. In its general appearance this train closely follows its earlier English prototype, and another cut—not reproduced—shows the open third class gondola bodied car common on the railways of our grandfathers. The turn-table under the locomotive antedates the switch of later inventing; but it is a device still used in some parts of this continent for a practically similar purpose, and its later development into a traverse-table is of very common application in France and Germany.

A TUNNEL UNDER THE CHICAGO RIVER, near Rush St., in Chicago, is proposed by Mrs. H. N. MAY, and the project is now before the Councils. The purpose of the tunnel, the estimated cost of which is $1,500,000, is to avoid the frequent delays and rush due to the open drawbridges at the river. The only tunnel now connecting the North and South Sides is that at La Salle St., too remote to be of service in this connection and mainly used by the cable roads. The Washington St. tunnel runs east and west, and is still further away. A committee of prominent citizens have taken up the matter and are now discussing plans for raising the money so that the tunnel may be finished in time for the World's Fair. All unite in the urgent necessity for some such relief from the existing state of affairs.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Chicago & West Michigan.—About 25 miles of track have been laid on the extension of this railway to Charlevoix, Mich., and the grading is well advanced toward completion.

Wabash.—Press dispatches state that work has been begun in two places on the proposed line from Montpelier, O., to Hammond, Ind., and will be rapidly pushed.

Central Counties.—The division of this Canadian road from Glen Robertson to Hawkesbury, Ont., 21 miles, has been completed with the exception of a small amount of ballasting.

Boston & Maine—In relation to the proposed cut-off connecting the Northern and Passumpsic divisions, mentioned in our issue of Oct. 24, Paul R. Long, General Counsel, has made the following statement:

A surveying party of 15 men sent out by the Boston & Maine Railroad has practically completed a survey for a link from Canaan N. H., to Fairlee, Vt., to connect the Northern and Passumpsic systems by a short cut. The route is found to be entirely feasible and is what is known as the old Goose Pond Line. This enterprise is one of the three that will give the Canadian Pacific a much shorter

route from Montreal to Boston. The other two are the shortening of a portion of the St. Johnsbury & Lake Champlain R. R., and also the building of a short cut from St. Constant to Rouse's Point.

Pittsburg, Ohio Valley & Cincinnati.—It is stated that J. K. Miller, of Bellaire, O., who has the contract for laying the track between Bellaire and Powhatan, O., 15 miles, will begin work in a few days.

Philadelphia & Reading.—A press dispatch from Elmira, N. Y., says:

The long talked of extension of the Philadelphia & Reading R. R. to this city, to connect with the Elmira, Cortland & Northern, begins to assume tangible shape. For several years an effort has been made to secure the right of way for a horse car line through State St., in this city, but the project did not meet with success. A new company recently secured the privilege from the Common Council to lay tracks on the street, but no work has been done. Colonel Robinson, who operates the car lines of the city, fished out an old ordinance giving the right to a company, and purchased the franchise. To the great surprise of every one rails have been dumped upon the ground, and the work of building the State St. line will be begun at once. This move is said to be in the interest of the Reading company, and every obstacle has been removed. The East Side Ry. Co. will oppose the new scheme, and the matter will probably go to the courts.

Bristol.—Tracklaying on this road from New Haven to Bristol, Vt., 6½ miles, is completed, with the exception of a short piece at Bristol Station. Work is now in progress ballasting the line.

Pittsburg & Moon Run.—This railway from Groveton to Remington, Pa., 6 miles, has been completed and opened for traffic. The road penetrates a good coal country and its business will be principally the coal shipment, although a "combination" train will be run to provide for the passenger traffic.

Pittsburg, Shenango & Lake Erie.—About 10 miles of the extension to Conneaut Harbor, O., has been graded and tracklaying is well advanced. There is a talk of changing the route into Conneaut so as to have the terminus nearer the center of the city.

Worcester & Shrewsbury.—The proposition to extend this Massachusetts railway to the town of Shrewsbury, Mass. was defeated at the recent election. A plan is now under consideration to extend the road to Marlboro, Mass., about 16 miles. The line would run from the main line near Lake View across Quinsigamond Park and along the route of the old Worcester & Hudson R. R.

Lower Laurentian.—The section of this railway from St. Tite Junction to Rivere à Pere, P. Q., 39 miles, has been completed and inspected by the Dominion and Provincial inspectors. An early extension of the line from St. Tite to Three Rivers is under consideration.

Western New York & Pennsylvania.—President Calvin H. Allen in his report says:

It is proposed to build in the interest of the Western New York & Pennsylvania a road from Oil City to near Turner's Station, on the Stoneborough & Newcastle division of the Western New York & Pennsylvania, a distance of about 43 miles. This piece of road will form a continuous line for the Western New York & Pennsylvania from New Castle to Oil City, thence by way of Olean to Rochester and Buffalo, and also from Oil City via Mayville to Buffalo, making connections with all of the great lines of the east in the states of New York and Pennsylvania.

Au Sable & Northwestern.—It is stated that this company will extend its road to Bear Lake, two miles south of Vienna, Mich., about 30 miles, during the coming season.

Mt. Carmel & Natalie.—This railway running from Mt. Carmel to Natalie, Pa., 5.5 miles, has been opened for traffic. The road connects with the Philadelphia & Reading R. R. at Mt. Carmel, and reaches the anthracite coal mines of the Pennsylvania Anthracite Coal Co., in the vicinity of Natalie.

Projects and Surve

Albany Terminal.—This old project has been revived and there is some prospect that the scheme will be carried out. The object of the company is to build a short line of railway along the New York Central and Hudson River R. R. above the factories in Tivoli Hollow, along Tivoli St. and across Broadway, in Albany, N. Y., to the Delaware & Hudson Canal Co.'s tracks, together with warehouses for the storage of goods. The company will not operate the line itself, but proposes to lease it to the New York Central & Hudson River R. R. Co., which it expects to interest in the enterprise.

New Boston.—Bartlett, Gay & Young, of Manchester, N. H., are locating this proposed railway from Parker's Station on the Manchester & North Weare R. R., to New Boston, N. H., about 5 miles. G. A. Wason, New Boston, N. H., is President.

Akron Transfer.—Incorporated in Ohio to build a transfer railway from the terminus of the Pittsburg, Akron & Western R.R., at Akron, O., to a connection with the Cleveland, Akron & Columbus R. R. near Old Forge Crossing. Among the incorporators are: C. W. Risley, John T. Powell and J. N. Holloway.

Maine Shore Line.—The engineers engaged in surveying the route of this proposed Maine railway have completed their field work for the season.

Attica & Freedom.—Chartered in New York to build a railway from Attica, N. Y., to Fish Lake, N. Y. The incorporators are H. A. Oakley, Richard B. Ferris and S. R. Stone, of New York City. These men are all directors of the Tonawonda Valley & Cuba R. R. Co., which operates a narrow gage line from Attica to Sandusky, N. Y., and this is probably a new name for that road.

Sugar Run.—Chartered in Pennsylvania to build a railway from Sugar Run Junction to Sugar Run Station, McKean Co., Pa. Among the directors are: W. S. Lewis, Couderrport, Pa.; A. A. Healy, New York City, and Geo. E. Brown, Wellsville, N. Y.

Chicago, Indianapolis & Chattanooga Southern.—A correspondent writes us as follows:

This railway is projected to run from Rockport, Ind., if that city votes a tax in its aid, otherwise from Tell City, Ind., north via St. Meinard, Ferdinand, St. Anthony, French Lick, West Baden, Mitchell, Bedford and Nashville to Indianapolis, Ind., a distance of 172 miles. About 70 miles have been located and estimates are now being made. Contracts will probably be let about Feb. 10, 1892, and it is expected to complete the road for the World's Fair traffic. The route is through a hilly country, but as the valleys have been followed a very favorable line has been secured. There will be one tunnel about 1,500 ft. long penetrating sand rock. Nearly all of the right of way has been secured. No other local aid has been obtained yet, but the company expects to obtain about $300,000. The principal business will be in coal, timber and stone and general merchandise. The road will enter into competition with no other line. The directors are: B. R. Cowen, Cincinnati, O.; D. P. Erwin, Indianapolis, Ind., and T. B. Galloway and F. L. Patrick, Columbus, O. The company was chartered Oct. 24, 1891.

Southern Central.—A press dispatch says that it is stated on reliable authority that work on this road will be commenced before Jan. 1, 1892. The road as surveyed is projected to run from Sunbury, Pa., to the Philadelphia & Reading R. R., a distance of 45 miles. C. W. McKechan, of Philadelphia, Pa., is President.

SOUTHERN.—Existing Roads.

Montgomery, Tuscaloosa & Memphis.—It is reported that tracklying will soon begin on this road at Maplesville, Ala., and also that contracts are being let for the division between Centerville and Tuscaloosa, Ala.

West Virginia & Pittsburg.—The engineers have finished the location of the extension of the Buckhannon Branch to Martin's Bottom, in Pocahontas Co., W. Va. The route, which runs up Williams River, is stated to be an excellent one, without very heavy work, with the exception of an 800 ft. tunnel.

Ashley River.—The rails which are to be used on the extension of this line have arrived at Charleston, S. C. The grading has been completed on the entire line and tracklaying is in progress. The extension is expected to be completed in ample time for the phosphate shipment this winter.

Chesapeake & Ohio.—This company has decided to double track its line between Alderson and Lowell, W. Va., 10 miles.

Macon & Atlantic.—The United States Court has appointed Henry J. Lamar receiver for this company on a petition filed by McLaughlin Bros., contractors for building a portion of its proposed line.

Abingdon Coal & Iron.—Contracts for the remaining 7 miles of this railway between Abingdon and Damascus, Va., have been let to W. P. Fortune & Sons, of Wilmington, N. C. The total length of the line between Abingdon and Damascus is 15 miles.

Greenbrier & Ganley.—It is stated that tracklaying has begun on this line from Alderson, W. Va., north to the Gauley River. Only a short section to the mouth of Laurel Creek will be laid this fall to enable the contractors to ship their supplies by rail.

Morristown & Cumberland Gap.—The rails necessary to complete the remainder of this road between Morristown and Corryton, Tenn., 44 miles, have arrived, and tracklaying will be resumed at once. It is expected to have the line completed by Dec. 1.

Roanoke & Southern.—The Giles Young trestle, about 13 miles north of Rocky Mount, Va., has been completed. The structure is 850 ft. long and 80 ft. high, and was built by A. W. Grove. Mr. Grove is reported as saying that the grading, bridging and trestles from Martinsville, Va., to Rocky Mount were completed.

Projects and Surveys.

Hinton & New River.—J. H. Miller, of Hinton, W. Va., writes us that this company will be organized Nov. 21. The proposed road is to run from Hinton to the mouth of East River, about 33 miles.

Montgomery, Hayneville & Camden.—It is officially stated that this company is about ready to begin the construction of its proposed line from Camden to Montgomery, Ala., 73 miles.

Brunswick, Western & Southern.—This company has made a proposition to the people of Brunswick Co., N. C., to complete its proposed line from Wilmington to Southport, N. C., and 5 miles west of Southport, within 8 months, and through Brunswick Co. to the South Carolina line within 18 months on condition that they vote $100,000 of bonds in aid of the road. An election has been called for Dec. 22 to vote on the question. It is stated that surveys for the line have begun.

Guntersville & Scottsboro.—The old management of this company has sold its interests to Boston, Mass., parties, as noted in our last issue. According to the contract the new management obligates itself, under a penalty of forfeiting $5,000, to expend $15,000 in actual construction within 5 months. The new officers are: President, William E. Baskett, Chattanooga, Tenn.; Vice-President, Alvah Wiswall; Secretary and Treasurer, Samuel P. Dodson, 1 Beacon St., Boston, Mass.

Jessup & Waynesville.—P. D. B. Stansell, of Jessup, Ga., writes us as follows:

This company has been chartered in Georgia by J. J. Bell and myself to build a railway from Jessup to Waynesville, Ga., a distance of 30 miles. The route is through a farming and timber country affording easy grades and curves and light work. All of the right of way will be granted gratis, and it is hoped to secure other aid. No effort has been made to secure capital yet. No organization has been effected and no surveys made, but we expect to begin surveys about the first of the coming year.

Fordsville, Hartford & Southwestern.—This company, chartered last December, has asked that elections be held in the towns along its route to vote on the question of granting a subsidy in aid of the enterprise. The road is projected to run from Fordsville, Ky., via Hartford, Ky., to a junction with the Chesapeake, Ohio & Southwestern R. R., in connection with which it will be operated.

NORTHWEST.—Existing Roads.

Chicago Central.—It is announced that this road will soon be in operation. It has been built from Blue Island north to Seventy-fifth St., in Chicago, a distance of 7 miles. It runs to Western Ave., and about 600 ft. west of it. It curves in a northeasterly direction from Seventy-ninth St. to its intersection with the Belt Line just west of the Panhandle road, where it turns and runs directly north and parallel to the Panhandle until it reaches the Santa Fe and Grand Trunk railways at Forty-ninth St. From Seventy-ninth St. to Brighton the grading has been nearly completed, and the laying of the track on this portion of the road and the crossing of Fifty-fifth St. Boulevard will complete the entire road from Blue Island into the city.

Burlington & Missouri River.—Dispatches state that the contract for grading 27 miles of the Wyoming Extension west from Gillette, Wyo., has been let to Kilpatrick Bros. & Collins.

Dakota, Wyoming & Missouri River.—Wm. T. Coad, Rapid City, S. Dak., President, writes us as follows:

The surveys have been completed for this railway, which is projected to run from Rapid City, S. Dak., west via Big Bend, Pactola, Canon City and Mystic, a distance of 80 miles. The route is through the only supply of lumber for Nebraska and South Dakota. The work will be quite heavy; maximum grade 90 ft. per mile and maximum curve 16°. C. D. Crouch, of Rapid City, S. Dak., has the contract for grading the line from Rapid City to Mystic, S. Dak., 31.6 miles, the work to be completed by Jan. 1, 1892. Tracklaying will begin as soon as the grading is completed and the road will be opened for traffic about Feb. 1, 1892. The principal business of the road will be in coal, lumber and iron, gold and silver ores. F. S. D. Broughton, of Rapid City, S. Dak., is Chief Engineer.

Projects and Surveys.

Bayfield Harbor & Great Western.—H. C. Hale, of Bayfield, Wis., Clerk, writes as follows:

This road is projected to connect the great terminal harbor at Bayfield, Wis., with the great transcontinental lines, viz., the Northern Pacific, the Great Northern and the Canadian Pacific systems. The proposed line will be about 40 miles long, and surveys are now in progress. The route is through a pine timber country affording easy grades and curves. Nearly all of the right of way has been secured, and the city of Bayfield has subscribed $45,000 in aid of the enterprise. The business of the road will be the lake freight to the West and the stock and grain shipment to the East, together with the local timber traffic. Offers for the construction of the road will be entertained. William F. Dalrymple is President, and D. F. Glover is Chief Engineer.

Pueblo & Duluth.—This company has opened general offices at Neligh, Neb., and active business preparatory to the construction of the line will begin at once. The company, which was incorporated in 1890, proposes to build a railway from a point on the west bank of the Missouri River, opposite Sioux City, Ia., southwest to Pueblo, Colo. Considerable work has been done making surveys and securing right of way and other local aid from the towns and counties along the route. The officers of the company are: President, D. Hitchcock; Vice-President, James Hunter; Treasurer, Wm. A. Winant; and Secretary, Thos. Marwood.

Murphy Lumber Co.—A press dispatch from Green Bay, Wis., says:

A force of engineers has begun to survey a line for the Murphy Lumber Co.'s new logging railway, extending from town No. 3,616, near Armstrong Creek on the Minneapolis, St. Paul & Sault Ste. Marie R. R. down through town No. 3,716. The road will terminate at the main Peshtigo River, a distance of 22 miles. Arrangements have been made with the Peshtigo Co. by which the logs brought over this road will be driven to the mouth of the river, where they will be towed to the Murphy mills in this city. The line was decided on because the Minneapolis, St. Paul & Sault Ste. Marie R. R. and the Milwaukee & Northern R. R. demanded an excessive rate for hauling the logs.

Canada, La Crosse & Southwestern.—At the meeting of the directors of this company recently held the following officers were elected: President, F. A. Roziene; Vice-President, A. McMillan; Treasurer, S. S. Burton, and Secretary, R. Calvert.

SOUTHWEST.—Existing Roads.

Greenfield & Northern.—Surveys will soon begin for an extension of this railway from Mt. Vernon, Mo., south to a connection with the St. Louis & San Francisco R. R. L. W. Shafer, Greenfield, Mo., President.

Missouri Pacific.—Work on the Houston, Central

Arkansas & Northern R. R. bridge at Alexandria, La., is making good progress. The piers are nearly completed and the iron-work is on the ground ready for erection. Tracklaying between Riverton and Alexandria is proceeding at the rate of two miles per day.

Pan American.—The contract for building the first 50 mile section from Victoria, Tex., south is reported let to J. H. Barrett.

San Antonio & Aransas Pass.—The engineers of this company have competed the preliminary survey for the line from near Yoakum, Tex., to Galveston, Tex.

Texas & Pacific.—A press dispatch says:

The Texas & Pacific Ry. has ordered the construction of seven large terminal buildings at El Paso, Tex., and the laying of their own track in from Sierra Blanca, Tex., a distance of 90 miles, where they have heretofore connected with the Southern Pacific. It is believed that the Texas & Peific will make a bid for the proposed El Paso & Denver Air Line, thus giving a big pull on the Western, Southwestern and Mexican traffic.

Austin & Northwestern.—Engineers will soon be placed in the field to survey the proposed extension to Llano, Tex.

Projects and Surveys.

Clayton & Forest Park.—This railway company has been chartered in Missouri with a capital stock of $50,000. T. K. Skinner, St. Louis, Mo., President.

Texas.—A number of the prominent citizens of Palestine, Tex., are talking of organizing a company to build a railway from that place to a connection with the Texas Trunk R. R. at Kemp, Tex. The length of the line would be about 60 miles. Among those interested are Geo. W. Burkitt, T. F. Murchison and Geo. A. Wright, all of Palestine, Tex.

ROCKY MT. AND PACIFIC.—Existing Roads.

San Joaquin Valley.—About 15 miles of track have been laid from Fresno, Cal., north toward Hamptonville.

Southern Pacific.—It is stated that the engineers, who have been surveying the proposed line from Bakersfield, Cal., to oil wells about 50 miles southwest, have been ordered to go to Armona, Cal., and continue the survey of the Tracy-Los Banos branch from that place to Bakersfield.—This company is reported to be considering the construction of a branch to Phœnix, Ariz.

It is stated that Bright & Crandall, of Redlands, Cal., have the contract to grade the branch from Mound City to Redlands, and that work is now in progress.

Great Northern.—The 12-mile line from Monarch to Neihart, Mont., has been completed, and will be opened for traffic in a few days.

Mason County Central.—Work on the 2-mile extension of this railway from Shelton to Isabella Lake, Wash., will begin soon.

Burlington, Cedar Rapids & Northern.—This company has a corps of engineers in the field locating a branch from Trosky to Jasper, Minn., to open up quarries.

Republican Valley & Wyoming.—A press dispatch states that the work of building this railway has begun. It is to run from Culbertson, Neb., to Holyoke, Colo., about 35 miles.

Projects and Surveys.

Denver & El Paso.—Andrew McClelland, of Pueblo, Col., writes as follows:

Our enterprise has only gone far enough to raise the money necessary to make the surveys for the proposed line. The engineers are now in the field. The road will be about 420 miles long and will run from Trinidad, Colo., along the Mora Valley via Las Vegas and White Oaks, N. Mex., to El Paso, Tex. The route is through a naturally rich country, and it is expected a large traffic in coal, iron soda and general merchandise will be secured. The road has not been named yet. O. L. Houghton, Las Vegas, N. Mex., is General Manager.

Salt Lake & Los Angeles.—According to a dispatch from Los Angeles, Cal., to the San Francisco *Examiner* a project headed by Ex-Mayor W. H. Workman, of Los Angeles, is on foot to build a railway 240 miles long, connecting the Union Pacific Ry. at Milford or Frisco, Utah, with the Atlantic & Pacific R. R. at Ludlow, Cal.

Colorado Southern.—Chartered in Colorado to build a railway from a point on the Denver & Rio Grande R. R., at Texas Creek, southeast to West Cliff, Colo. Among the incorporators are: E. C. Humphrey and J. R. Smith, of Denver, Colo.

Silver City, Pinos Altos & Mongallon.—The locating surveys for this line from Silver City to Pinos Altos, N. Mex., 7½ miles, have been completed, and contracts for construction will probably be let in a short time. The road will be standard gage, and it will be operated in connection with the Atchison, Topeka & Santa Fe R. R., and will use that road's terminus at Silver City. The work will be very heavy mountain work; maximum grade 4% and maximum curve 16°. D. H. Newcomb, of Silver City, is President, and Robert Giles, of Topeka, Kan., is Chief Engineer.

FOREIGN.

Peninsular California.—Sir Edward Jenkinson, in a report to the shareholders of the Mexican Land & Colonization Co., says:

A separate company has been formed, under the name of the Peninsular California Ry. Co., for the purpose of carrying out the building of the railways mentioned in the concession from the Mexican Government in the peninsula. The first railway is to run from San Quentin via Trinidad Valley, to Colorado River and Yuma, and the other branch is from Tia Juana to Trinidad, where it forms a junction with the line from San Quentin to Yuma. The company has been formed for the purpose of constructing the first line, and measures have been taken to go on with the second portion of the work. The first contract for a section of the line commencing from San Quentin to Yuma has been given to the Lower California Development Co., through whose property it runs for 43 miles, and work has been commenced.

Mexican Central.—About 13 kilos. of the Pachuca Branch have been completed, and it is expected to have the entire line completed by Jan. 1, 1892.

Guadalajara & Chapala.—Mariano Coronado and Cenobia I. Enciso have received a concession from the Jalisco, Mexico, State Legislature to build a railway from Guadalajara to the Lake of Chapala.

Intercontinental.—Ground has been broken for building this proposed railway from Matamoros, Mex., to Central America.

CITY TRANSIT.

Electric Railways.—*Hyde Park, Mass.*—The Norfolk & Suffolk Street Ry. Co. has been granted a franchise for a line from Boston to Hyde Park and Dedham.

West Chester, Pa.—Mr. E. B. Moore has projected a road 21 miles long to Philadelphia.

Middletown, Del.—The Middletown & Odessa Ry. Co. will soon commence work on its line, which will be 4 miles long.

Salem, Va.—The Salem Street Ry. Co. will build an electric line.

Fort Wayne, Ind.—The Fort Wayne Street Ry. Co. is trying a Slattery storage battery car.

Saginaw, Mich.—A storage battery car is being experimented with.

Chicago, Ill.—An ordinance has been passed granting a franchise to the Torrence Electric Terminal Ry. Co.

Lincoln, Ill.—An electric railway is to be built very soon.

Mankato, Minn.—A franchise has been granted for an electric road.

Dubuque, Ia.—Three more storage battery cars have been put in service, making 9 in all.

Austin, Tex.—The city's railway to the dam has been leased by D. C. McMartin, of Des Moines, Ia., and Richard Snell, of Kansas City, Mo., who will equip it for electric traction.

San Diego, Cal.—The street railway system has been purchased by A. B. Spreckels, who will introduce electric traction.

Cable Railway.—*Catskill, N. Y.*—A cable railway 1¼ miles long, and rising 1,700 ft., is to be built from the terminus of the Catskill Mountain Ry. at the foot of the mountain to the Catskill Mountain House. The Otis Elevator Co., of New York, is said to be interested.

Elevated Railway.—*Chicago, Ill.*—The City Council has granted a right of way to the Chicago Elevated Ry. Co. This is the line projected by Gen. Torrence, the ordinance for which has been long pending. The ultimate purpose is practically to abolish surface steam traffic in Chicago and to establish a central freight clearing house for all the railways entering the city. The right of way extends from 12th St., anywhere between the river and the lake, to State and 67th Sts., and thence east of State St. to the city limits.

Horse Railways.—*Macon, Ga.*—The North Macon Street Ry. will build a road.

Portland, Me.—The Portland Ry. Co. will extend its road to Deering and Westbrook.

BRIDGES, TUNNELS AND CANALS.

Bridges.—*Pleasant Hill, Mich.*—A bridge is to be constructed over Brown's Run, near this place. C. H. Smith, Pleasant Hill.

Avoostook Co., Me.—The town of Caribou will replace the bridge recently burned with an iron structure.

Great Barrington, Mass.—This town has appropriated $3,500 for an iron bridge over the Housatonic River.

Memphis, Tenn.—The City Council has adopted a resolution providing for the construction of a $10,000 iron bridge over Gayoso Bayou at Mill St., Memphis, Tenn. The Mayor can give further particulars.

Alton, Ill.—A dispatch from Alton, Ill., says the bridge across the Mississippi River at that point, which has been projected for several years, is to be built at once. The official announcement is in the shape of an application to the Alton City Council for an ordinance granting certain franchises and land for switching facilities.

Canals.—A. J. Corcoran, of Stockton, Cal., Manager of the Navigation & Improvement Co., which operates a line of boats along the San Joaquin River from San Francisco Harbor to Firebaugh Ferry, is pushing a project to extend the boat line to Fresno, Cal., by means of building locks in the river and the construction of a short line of canal. It is estimated that the cost of the proposed improvement would be about $1,000,000.

HIGHWAYS.

Massachusetts.—J. Thissell & Son, of Clinton, are engineers for a new road to Sterling. It will be 20 ft. wide with a crown of 18 ins. from the bottom of the ditches and is to be covered with 8 ins. of gravel.

Alabama.—The Jefferson County Commissioners have advertised for bids on the construction of 7 miles of turnpike. The county has now 110 miles of macadamized roads and there are about 30 miles now under contract. The additional 7 now under contract will make in the aggregate about 150 miles of macadamized roads in the county. Contracts were let recently for 20 miles of macadamized roads.

Oklahoma.—The Board of Trade of Guthrie has decided to build a road to Chandler.

Colorado.—The contract for the State wagon road in Douglas Co. has been awarded to the Western Construction Co., of Denver.

WATER-WORKS.

NEW ENGLAND.

Hallowell, Me.—H. L. Merchant, J. R. Gould and S. G. Otis have been appointed by the city officials as a special water supply committee. Surveys are being made for proposed city works. The present system is owned by a company.

Antrim, N. H.—Favorable progress is reported for the water-works project.

Collinsville, Mass.—Works are being built by Michael Collins. Water will be pumped from a mill pond to a small reservoir. Estimated cost, $25 000.

Lynn, Mass.—Bonds for extensions to the amount of $25,000 have been authorized.

New Bedford, Mass.—About 2,000 ft. of pipe has been ordered laid.

Pittsfield, Mass.—A pumping station will be erected at Lake Ashley at a cost of $3,000, the money having been appropriated.

Woburn, Mass.—The sum of $11,000 has been appropriated for the new reservoir basins.

MIDDLE.

Geneva, N. Y.—The mains are to be extended to Torrey Park, an addition to the village.

Port Jervis, N. Y.—The company has contracted with Benjamin Von Vranken to raise the storage reservoir dam 10 ft. which, it is said, will give 90,000,000 galls. additional capacity.

Wurtsboro, N. Y.—A meeting to discuss works will soon be held.

Newark, N. J.—A. Fteley has recommended the construction of a storage reservoir at the lower end of the new supply pipe line.

Bellwood, Pa.—The Bellwood Water Co. will soon begin the construction of a reservoir on Shaw's Run. It is said that the principal mains will be laid by next May.

Dushore, Pa.—The *Review* advocates a supply from a spring three miles distant.

McKeesport, Pa.—The awarding of contracts for two 3,000,000 gall. pumps has been postponed to Nov. 19. The lowest bid, as reported by the *Times*, was from the G. F. Blake Manufacturing Co., N. Y. City, $22,000.

Montrose, Pa.—It is reported that the franchise has expired.

Reading, Pa.—One-half of the $150,000, 4% water loan will be sold Jan. 1, and the remainder April 1, 1892.

SOUTHERN.

Richmond, Va.—The Council's Water Committee has recommended the passage of an ordinance providing for the introduction of meters wherever the committee deems them advisable. A rental of 10% on the cost of the meter and setting the same is provided for.

Wheeling, W. Va.—It is reported that a contract has been let for two Gaskill pumps; price, $125,000.

Athens, Ga.—There is talk of building city works, owing to an alleged deficiency in the company's supply.

Savannah, Ga.—Bids for laying pipe are wanted until Nov. 23. Address F. E. Rebarer, Clerk of Council.

Scottsboro, Ala.—Works are wanted.

Uniontown, Ala.—A contract for works has been let.

Cleveland, Tenn.—It is reported that a new proposition for the construction of works will be made to the Council.

Ludlow, Ky.—The Covington Water Commissioners have offered to sell water to Ludlow at 11 cts. per 1,000 galls. for five years, after which they will deduct one cent and continue to do so at the expiration of each five years until a 25-years contract expires. The Ludlow Committee will recommend its citizens to accept the proposition.

NORTH CENTRAL.

Bowling Green, O.—J. M. Howells, Chicago, has recommended that a supply be obtained from the North branch of the Portage River, by pumping to a tank. A dam flooding 16 acres and located about 1½ miles from the village is proposed, and about 11 miles of mains. Estimated cost, $135,000.

Hammond, Ind.—Plans and specifications for improvements have been prepared by C. McLennan, Chicago. For further details see our "Proposals" columns.

Huntingdon, Ind.—W. B. Ewing, Engineer, informs us that a well 20 ft. in diameter and 32 ft. deep has been sunk.

Princeton, Ind.—C. W. Benton, City Clerk, informs us that a franchise was granted Nov. 9 to the Princeton Water & Lighting Co. Works must be in operation by July 1, 1893.

Benton Harbor, Mich.—Bonds for works have been sold.

Iron Mountain, Mich.—It is reported that "a better water supply" will be secured.

Rockford, Mich.—Works are wanted.

Arcola, Ill.—The town has voted $12,000 for works.

Belleville, Ill.—G. F. Hilgard and Louis Grover are making surveys for a possible supply from the Okaw River.

Effingham, Ill.—L. H. Bissell informs us that works will be built next spring.

Fairbury, Ill.—The sum of $15,000 has been voted for an artesian well and extensions to the mains.

Lake Forest, Ill.—It is reported that filters are being added.

Olney, Ill.—It is reported that works costing $20,000 will be built.

Marshfield, Wis.—It is reported that Moffett, Hodgkins & Clarke, Syracuse, N. Y., have abandoned their franchise and that a new one will be granted.

NOTRHWESTERN.

Jackson, Minn.—Bonds for works to the amount of $10,000 have been voted.

Chadron, Ill.—The contract for improvements has been let to E. A. Rudiger, Nebraska City, for $19,650.

Watertown, S. Dak.—It is reported that the city has offered to build a dam across the outlet of Lake Kampeska, provided the water company will pay $150 of the expense.

Yankton, S. Dak.—A supply for the north side is proposed from an artesian well, a company to build works which will be bought by the city, the latter to guarantee interest on the company's bonds. Estimated cost, $15,000.

SOUTHWESTERN.

Aurora, Mo.—The Aurora Water Co. was incorporated Oct. 31; capital stock, $100,000.

Cape Girardeau, Mo.—Proposals for a franchise will be received until Dec. 7. Johnson & Fiadd, St. Louis, are Engineers; H. P. Peironnet is Mayor and G. E. Chappell is Register.

Helena, Ark.—Works are reported as under construction by the Helena Water Co. Wells are being driven and a stand-pipe has been contracted for.

Beaumont, Tex.—Bids for furnishing about 6,000 ft. of 6-in. pipe and 14 hydrants, with necessary valves, and for laying and setting the same are invited by the city until Nov. 17. W. A. Ives is City Secretary.

Cleburne, Tex.—The citizens wish the mains extended.

New Braunfels, Tex.—Bonds to the amount of $8,000 have been issued or authorized for improvements.

Orange, Tex.—O. J. Gorman, Dallas, has made a proposition to build works.

Waxahachie, Tex.—Agitation for works has been renewed. A supply from artesian wells is favored.

PACIFIC.

Kent, Wash.—About $15,000 of bonds for works will be issued.

Elgin, Ore.—The *Recorder* is trying to arouse the people to try to secure works.

Oakesdale, Ore.—Works are being considered.

Woodstock, Ore.—Works with a supply from a 180-ft. well are being built. An electric pump is said to be in use. T. H. Gray has charge of the works.

Berkeley, Cal.—It is thought that private parties will make a proposition to build the proposed salt water system for fire and street purposes.

Colton, Cal.—The company has employed G. O. Newman, Riverside, as engineer for the addition of artesian water to the present supply.

ARTESIAN WELLS.

Fishkill, N. Y.—Experimental wells will be sunk for the state asylum.

Goshen, N. Y.—W. W. Phillips, Ridgewood, N. J., will make a proposition to sink a well and add a windmill to to increase the supply.

Walterboro, S. C.—It is reported that a well will be bored near A. Wichman's store.

Albany, Tex.—A well is projected.

Pukwana, S. Dak.—A large well will be sunk, according to report.

Arlington, Tex.—The *Herald* advocates the sinking o a well.

Emma, Tex.—It is reported that a well will be sunk.

Waco, Tex.—It is reported that the Bell Water Co. is sinking two 10-in., and the Water & Light Co. two 8-in. wells.

IRRIGATION.

Converse Co., Wyo.—Work has been started on the Moss Agate Ditch, which will be 15 miles long and 12 ft. wide on the bottom.

Anderson, Col—The *Enterprise* states that an election has been carried for the organization of the Happy Valley Irrigation District. The next step is to hold a bond election.

Escondido, Cal.—The Directors of the Escondido Irrigation District will receive bids until Nov. 26 for the purchase of $450,000 of 6% 10-20 bonds. A. J. Werder is Secretary.

Pasadena, Cal.—An irrigation district co-extensive with the city limits is proposed.

Pomona, Cal.—A contract has been let for a tunnel 1,200 ft. into the mountain to develop 1,600 ins. of water to irrigate 1,800 acres in the Pomona Valley, and also to be used for an electric power and lighting plant to supply Pomona, Chino and Ontario.

New Companies.—Central Water & Ditch Co., Hood River, Ore.; $15,000; H. F. Davidson, C. P. Heald and others; to construct ditch 8 ft. wide at bottom, 12 at top, 2 ft. deep, to supply water for household and irrigating use. Fresno Flume & Irrigation Co., Fresno, Cal.; $500,000. Iowa Ditch Co., San Francisco, Cal.; $24,000, of which $11,600 has been subscribed; directors, E. H. Miller, L. J. Holton and others; to construct ditch in Fresno Co. to take water from Fowler Switch Canal. Susanville Water Co., Susanville, Cal., $300,000; water-works and irrigation. Tulare Land Canal Co., Tulare, Cal.; $50,000; directors, Walter Turnbull, E. B. Pond and others.

SEWERAGE AND MUNICIPAL.

Sewers.—***Vermont.***—Barre. The sewerage of the Richardson district is being built by Ward & Douglas.——Burlington. Mr. F. P. Stearns has made a report on sewage disposal to the Board of Aldermen, with plans for preventing the pollution of the water supply at a cost of $10,259.

Massachusetts.—Revere. The Sewerage Committee has advertised for plans for sewage disposal.——Salem. The cost of the intercepting sewer for Ward 5 is estimated at $30,000.——Newton. The men at work on the sewers have struck owing to the failure of the contractor to pay them, and the work is being carried on by the city.

Rhode Island.—Pawtucket. A report upon sewage disposal is to be made by Mr. J. Herbert Shedd, City Engineer of Providence; Mr. J. J. R. Croes, of New York, and Mr. H. F. Mills, of Lawrence, Mass. Mr. A. R. Sweet is Engineer to the Sewer Commission.——Providence. The City Engineer has reported that it is advisable to complete the sewerage system before the disposal works, as the treatment of sewage can follow long before any nuisance can arise from its discharge at the new outlet.

Connecticut.—Southington. The borough officers are considering a proposition from a New York construction firm regarding a sewerage system, which it offers to put in on the franchise plan, the citizens paying rental for use of the same.

New York.—White Plains. The Board of Trustees is said to have decided not to put the Powers system of chemical precipitation into the sewage disposal house now in course of erection a little below the village. Mr. James Powers, of Brooklyn, the patentee, was to have received $36,000 for the putting in of his apparatus, and will be likely to sue for damages. The contract for the sewerage system of the village was given to John O. Merritt, of Port Chester, for $160,000. Powers' system was the one adopted, and Merritt contracted to pay him $33,000 for it, and the contractor was to receive $14,500 for the building in which the machinery was to be placed. The village authorities have appointed a committee to wait on the State Board of Health to get some new system from them.——Port Richmond. The trustees are considering plans for a general sewerage system. Some citizens favor bonding the the village and building a complete system at once. Others favor sewering only a portion of the village at present, and by the assessment system. The trustees will hold a special meeting.

New Jersey.—Plainfield. An ordinance for sewers was granted to J. W. Lowe, of the Common Council, on Nov. 3.——Bloomfield. The Township Committee has decided by a vote of four to two to unite with the city of Orange and the township of Montclair in the construction of the outlet sewer to tidewater at the Passaic River. The cost of the united outlet will be about $138 000 exclusive of the right of way.

Kentucky.—Bowling Green. Mr. J. H. Humphrey, Sanitary Engineer, estimates the cost of the proposed sewerage system at $213,639.

South Carolina.—Greenville. A report and plan for a complete system of sewerage have been prepared by Mr. C. P. Bassett, of Newark, N. J.

Georgia.—Columbus. An ordinance has been passed authorizing the issue of $135,000 for a sewerage system.

Indiana.—Indianapolis. The Board of Public Works hopes to have a new sewerage system outlined before next spring. City Engineer Mansfield has completed his survey of the city, and is now engaged in making a map to be used in laying out the sewerage system. Until the City Engineer completes his work the Board will not order the building of any more sewers, unless they are absolutely necessary.

Michigan.—Iron Mountain. The State Board of Health has ordered the construction of a system of sewers.

Illinois.—Chicago. An ordinance has been passed providing for a 6-ft. brick sewer on 73d St., from State St. to a point near the lake, and the erection there of a $60,000 pumping plant and an outlet. Property-owners in the neighborhood objected strongly, but failed to defeat the ordinance which creates a drainage district bounded by 71st and 75th Sts., State St. and the lake. It lies within the great sanitary district, and the objectors claimed that the city had no power to lay out a sub-territory and build sewers in it when that authority had been delegated to the Drainage Commissioners, but it was argued that until the Sanitary Commission made some move toward draining the territory the city still retained authority. Being so far south, no danger from pollution of the water supply is expected.

Minnesota.—Rochester. The Lewis Mercer Construction Co., of New York, has applied for a franchise for a sewerage system.

Missouri.—Webb City. The City Clerk has been directed to correspond with a sewerage construction company of New York in regard to a system of sewers.

Texas.—Beaumont. The City Council has advertised for bids for sewerage.

Washington.—Olympia. The plans of sewerage submitted by Mr. Camp, of Puyallup, have been accepted.——Port Townsend. Plans and specifications for a complete sewerage system are to be prepared by Mr. G. N. Miller.

California.—Pomona. The Board of Trade has passed a resolution in favor of a system of sewerage, and requesting the City Trustees to take the necessary steps.

Streets.—***Maine.***—Lewiston. Bearce & Clifford have the contract for the Walnut St. extension.

Massachusetts.—Cambridge. The Board of Aldermen have passed an order for the purchase of 300,000 paving blocks.

New Jersey.—Hackensack. The Township Committee has awarded the contract for macadamizing Hackensack Ave. to Wm. J. Marley.

Pennsylvania.—Philadelphia. It is expected that surveys will be commenced shortly for the proposed boulevard to the park. An ordinance has been prepared to prohibit the tearing up of newly paved streets and to provide for having all the preliminary work done when the sewers and water mains are first put down by extending connecting pipes beyond the curb on either side of the street, so that connections may be made from the houses built or to be built without having to touch sewer or main.

Virginia.—Roanoke. The contracts for macadamizing streets will amount to about 7.34 miles.

South Carolina.—Spartansburg. The city will macadamize the streets, and a steam stone crusher and street sprinkler have been purchased.

Florida.—Jacksonville Mr. J. F. LeBaron, C. E., has recommended Florida rock for paving material.

Illinois.—Chicago. A movement is on foot to provide for improved street paving before the opening of the World's Fair.——Alton. Brick paving is being extensively used.——Peoria. Appropriations amounting to $120,000 have been made for street and sewer work.

Texas.—Houston. The curbing for the street work, the contract prices for which were given last week, is to be of hard burned brick.

Utah.—Salt Lake City. The Board of Public Works has received bids for curbing and guttering with granite or sandstone, and for paving with asphaltum four blocks on State St. The distance to be covered is a little more than half a mile, and the paving is to be paid for by an assessment of abutting property owners. For the curbing the competitors were close together, but on the paving the bids ranged from $3 to $3.90 per sq. yd.

Bonds.—Knoxville, Tenn.; for bridges and sewers; to be voted on Dec. 19. J. W. Yoe, Mayor. Columbus, Ga.; $135,000 for sewers, $25,000 for city hall, $15,000 for hospital; vote to be taken Jan. 16. Dubuque, Ia.; for paving and curbing. Grand Junction, Col.; for streets and sewers.

Surveys.—Topographical surveys are being made of Roanoke, Va., and Jacksonville, Fla.

Street Cleaning.—***Elgin, Ill.***—The Elgin Street Sweeping & Sprinkling Co. has been incorporated by E. H. Ricker, J. C. Wiltsie and F. H. Cranston; $3,000.

ELECTRICAL.

Electric Light.—***Manchester, N. H.***—A contract for lighting the streets has been awarded to the Manchester Electric Light Co.

Lynn, Mass.—The Woodward Underground Electric Light & Cable Co. has petitioned for authority to open streets for the purpose of laying conduits.

Hazardville, Conn.—The selectmen have been petitioned to appropriate $20 per month for electric lighting and to make a contract with the Enfield Electric Light & Power Co.

Suspension Bridge, N. Y.—It is proposed to light the streets with 80 incandescent lamps, of which 60 are now in service, at a cost of $15 per lamp per annum.

Greensburg, Pa.—A contract for lighting the streets for 10 years has been awarded to the Westmoreland Light Co. at $80 per light per annum for 50 arc lights. Mr. M. L. Painter is president.

Leesburg, Va.—The contract for 15 arc lights for one year has been awarded to John Whipple at $1,200.

Wheeling, W. Va.—The Edison Electric Light, Heat & Power Co. proposes to construct a system at a cost of $500,000, and has applied for permission to lay underground wires.

Fort Valley, Ga.—The Fort Valley Investment & Improvement Co. requires a plant for a city of 2,500 people.

Wausau, Wis.—The city is to have 41 arc lamps at $90 per lamp per annum.

Farmington, Mo.—The Hockaday & Carter Co. furnishes 29 arc light of 32 c. p. at $600 per annum.

Snohomish, Wash.—The Edison Illuminating Co. has made a proposition to furnish 150 lights for $5 per month; 175 lights for $8.50 and 200 lights or over for $8 per month, the duration of the lighting contract to be three years.

Companies.—Long Island City Illuminating Co., of Long Island City, N. Y.; E. M. Tyrrell and W. A. Christian, of Brooklyn; J. W. Lamb, of Long Island City, $50,000. Northwest Thomson-Houston Electric Supply Co., of St. Paul, Minn.; president, E. P. Gilman; secretary, W. R. DeCelle, $400,000. Gray Electric Co., of Chicago, Ill., to manufacture the telautograph, etc.; Elisha Gray, F. W. Cushing and L. O. McPherson, $100,000. Atlantic Electric Light & Power Co., of Atlantic City, N. J.; C. L. Cole, H. J. Adams and C. E. Brown, $50,000. Morgantown Electric Light & Power Co., of Morgantown, W. Va.; H. S. Sands and O. S. McKinney, of Fairmont, $100,000. Wampa Electric Light & Power Co., of Wampa, Idaho; J. N. Johns and P. W. Purdum, of Wampa, and H. E. Simmons, of Summit, N. J.; $24,000. Taylor Electric Light, Gas & Power Co., of Taylor, Tex.; president, E. W. Pike; secretary, E. L. Welch, $40,000. Queens County Electric Light, Heat & Power Co., of Oyster Bay, N. Y.; W. A. Vail and Horace Ironmonger, of Brooklyn, $50,000.

CONTRACTING.

Cut Stone.—The contract for cut stone on the Coosa River improvement in Georgia and Alabama has been awarded to Frank Baldwin, Birmingham, Ala., at $19.93 per cu. yd. for granite.

Culvert.—The contract for rebuilding the culvert under the Erie Canal at Adam's Basin, N. Y., has been awarded by Edward Hannan, Superintendent of Public Works, to Wm. Fuller, of Rochester, N. Y., at $7,492.

Removing Wreck.—The following proposals for removing the wreck of a schooner from Nantucket Sound have been received by Major Livermore, U. S. Engineer Office, Newport, R. I.: Enoch Townsend, Somer's Point, N. J., $3,765; C. W. Johnston, Lewes, Del., $6,490; Boston Tow Boat Co., Boston, Mass., $10,450; Wm. E. Chapman, New York, N. Y., $14,690.

Sewers.—*Boston, Mass.*—The proposals given in the following table were received by the Metropolitan Sewerage Commissioners, Nov. 4. Section No. 21, Medford, 8,250 l. long, 11.5 ft. average depth, 6.5 ft. external diameter, 4,550 cu. yds. masonry; Section No. 22, Medford, 6,075 ft. 21.5 ft., 5 ft., 2,200 cu. yds.; Section No. 24, Everett and Charlestown, 2,300 ft., 22.7 ft., 9 ft., 2,350 cu. yds. The bidders were as follows: *A*, Jones & Meehan, Jamaica Plains; *B*, Collins & Ham, Boston; *C*, B. E. Malone, Lancaster, Pa.; *D*, Dennis O'Connell, Dorchester; *E*, Metropolitan Construction Co., Boston; *F*, A. A. Libby & Co., Boston; *G*, H. P. Nawn, Boston; *H*, National Construction Co., Boston.

Section No. 21.	Earth excav. and refill. 56 in. × 53 2,600 lin. ft.	Earth excav. and refill. 54 in. × 53 5,400 lin. ft.	Rock excav. 350 cu. yds.	Masonry. Brick, American. 1,800 cu. yds.	Brick, Portland. 850 cu. yds.	Concrete, American. 1,500 cu. yds.	Concrete, Portland. 200 cu. yds.	Rubble-stone, Am. 200 cu. yds.	Spruce lumber in place. 14 M. ft. B. M.	Spruce piles driven. 3,500 lin. ft.	Earth excav. and refill. outside of trench. 500 cu. yds.	Total.
	$	$	$	$	$	$	$	$	$	$	$	$
A..	6.00	6.00	5.00	13.00	15.00	5 00	7.50	6.00	30.00	0.20	1.50	98,270
B..	4.95	4.95	4.95	12.80	14.50	5.60	7.00	5.25	29.00	0.21	1.00	89,436
C..	4.25	4.25	5.00	13.25	15.00	5.00	6.25	2.25	30.00	0.25	0.75	83,432
D..	5 25	3 25	4.00	12.75	15.50	6.00	7.50	5.00	30.00	0.19	1.00	81,972
E..	5.25	3.37	4.50	12.25	14.40	5.38	7 37	5.40	27.00	0.14	1.25	79,998
F..	4.50	3.25	4.50	13.25	14.75	4.62	6.25	6.00	25.00	0.20	1.00	78,305
G..	5.00	3.00	5.00	13.00	14.00	5.00	6.00	5.00	35.00	0.20	1.00	77,790
H..	4.25	3.65	6.00	12.45	14.15	5.35	6.95	5.50	31.00	0.15	1.15	76,259
Sec. No. 22.	40 × 42 1,050 lin. ft.	36 × 38 5,030 lin. ft.	50 cu. yds.	950 cu. yds.	380 cu. yds.	500 cu. yds.	200 cu. yds.	200 cu. yds.	10 M. ft. B. M.	500 lin. ft.	500 cu. yds.	
A..	13.00	13.00	10.00	14.00	16.00	5.00	7.50	7.00	28.00	0.50	1.00	105,350
H..	5.05	9.75	5.00	13.05	14.50	5.85	7.00	5.75	35.00	0.15	1.25	79,027
E..	4.64	8.40	4.00	12.59	14.71	5.27	7.39	5.30	26.00	0.14	1.25	71,002
C..	6.30	6.00	0.50	12.00	14.25	5.75	7.00	2.25	30.00	0.25	0.75	59,160
Sec. No. 24.	72 × 80 2,300 lin. ft.		50 cu. yds.	800 cu. yds.	350 cu. yds.	900 cu. yds.	300 cu. yds.	200 cu. yds.	10 M. ft. B. M.	500 lin. ft.	500 cu. yds.	
A..	15.70	.....	6.00	13.00	15.00	5.00	7.50	6.00	28.00	0.30	1.50	61,190
B..	9 89	.....	5.00	12.95	15 00	5.50	7.00	5.50	28.00	0.17	0.90	47,572
H..	9.65	.....	5.00	12.15	14.00	5.35	6.50	5.50	30.00	0.15	1.25	45,930
E..	8.58	.....	0.50	11.95	14.24	4.95	7.17	5.00	27.00	0.14	1.25	42,874
C..	8.20	.....	0.50	12.00	14·25	5.50	6.50	2.25	30.00	0.25	0.75	41,622

PROPOSALS OPEN.

Pipe.—*Victoria, B. C.*—About 200 tons of 4-in. cast iron pipe, 150 tons of 5-in., 150 tons of 6-in., 100 tons of 8-in. G. W. C. East, City Clerk. Nov. 21.

Street Work.—*Kansas City, Mo.*—Stone flagging or artificial stone hexagon block sidewalks. E. Butts, City Engineer. Nov. 16.

Hannibal, Mo.—About 3,700 ft. of paving and curbing; street 70 ft. wide. F. R. Locking, City Engineer. Dec. 5.

Cincinnati, O.—Improving Dennis St. Board of Administration. Nov. 20.

Levee.—About 20,000 cu. yds. in Chicot Co.; all open field and average levee about 6 ft. E. S. Hilliard, Grand Lake, Ark. Nov. 18.

Road.—Earth drive 30 ft. wide, 8,466 ft. long in Baltimore Co. W. J. O'Brien, Jr., Secretary. Green Spring Valley Improvement Co., Baltimore, Md. Nov. 17.

Bridges.—Two wooden bridges and stone culvert. F. J. O'Flaherty, County Surveyor, Kansas City, Mo. Nov. 25.

Crane.—One 40-ton locomotive jib crane for New York Navy Yard. Chief of Bureau of Ordnance, Navy Department, Washington, D. C. Nov. 16.

Removing Rock.—At Gunter's Reef, Tennessee River. Lieut. G. W. Goethals, U. S. Engineer Office, Florence Ala. Nov. 30.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Schenectady Locomotive Works, of Schenectady, N. Y., report that they have just sent 5 compound passenger engines, cylinders 20 and 29 × 24 ins., and 1 compound freight engine, 20 and 29 × 26 ins., to the Southern Pacific; this is the third order for compounds furnished to that road; they have also an order for 5 engines for the Beech Creek road. The Baldwin Locomotive Works, of Philadelphia, Pa., have delivered the first of the ten-wheel compound engines for the New York, Lake Erie & Western.

Cars.—The Northern Car Co., of Minneapolis, Minn., has been incorporated by C. P. Jones, D. M. Gilmore, W. E. Steele and S. S. Thorpe. The Michigan Car Co., of Detroit, Mich., is building cars for the Burton Stock Car Co. The Barney & Smith Mfg. Co., of Dayton, O., is building 40 passenger cars for the Chicago, Milwaukee & St. Paul. The Buffalo Car Co. of Buffalo, N. Y., has built 200 box cars for the Fall Brook Coal Co. and has an order for 100 flat cars and 30 box cars for the Adirondack & St. Lawrence. The Gilbert Car Mfg. Co., of Troy, N. Y., has an order for 50 passenger cars and 10 vestibuled passenger cars for the New York Central & Hudson River. The Michigan Central is building at its shops at St. Thomas, Ont., 20 freight cars of 60,000 lbs. capacity, all equipped with air brakes.

A. M. Morse & Co.—Mr. A. M. Morse, until recently of the firm of English, Morse & Co., Kansas City, Mo., has removed to St. Louis, Mo., with offices in the Commercial Building. During the eight years that he has been in Kansas City he has designed and furnished a liberal proportion of the steam power plants in that section for electric lighting, electric railways and manufacturing purposes. The business in the future will be conducted under the style of A. M. Morse & Co., and will represent leading manufacturers of high grade steam engines of both Corliss and high speed type; also boilers, steam pumps and other specialties for steam power plants; as well as furnishing complete plant.

The Industrial Works, Bay City, Mich., report several orders for cranes of different types, including a large capacity steel transfer crane for the Chicago & Alton, a 10-ton portable steam crane, an electric traveling crane for the American Engine Co., of Bound Brook, N. J., a stationary steel crane for the New York Central & Hudson River, a 15-ton portable crane for the West India Improvement Co., and a steel car and cranes, with a capacity for lifting 30 tons, for the Central R. R. of New Jersey; also orders for 3 turntables for the Kansas City, Watkins & Gulf, a portable extension steam pile driver for the New York Central & Hudson River, a steam transfer table for the Wheeling & Lake Erie and a similar table for the Grant Locomotive Works of Chicago. The works have put in an electric plant for lighting the shops and for power purposes, and have commenced erecting a building 100 × 270 ft., which will be devoted principally to crane work, and will be equipped with electric traveling and other cranes and the latest machinery adapted to this class of manufacture. With the completion of this addition the present plant will be somewhat relieved and the total capacity of the works greatly increased.

The Interior Conduit & Insulation Co., of New York, N. Y., has acquired the sole right to manufacture and sell the arc lamps of the Universal Arc Lamp Co., and has devoted a large portion of its factory to this purpose.

The Duplex Street Railway Track Co. has commenced laying on Eighth St. and Fourth Ave., New York, its duplex track, with its under and over lapping principle of construction, described in our issue of Nov. 15, 1890.

Electric Motor.—An interesting test was made last week by Wm. L. Sellers & Co., of Philadelphia, upon a motor operated under the new principle invented by Mr. H. Ward Leonard. The motor was a 10-H.P. standard shunt wound Sprague motor, and its normal speed was 1,500 revs. per min. It was belted to a countershaft, upon which were placed a brake and a large fly-wheel such as is used upon punching machines, the purpose of the fly-wheel being to duplicate the inertia and momentum met with in practice in a great many kinds of work. The motor was made to operate in either direction at any rate of speed desired, and it was found possible to run the motor perfectly and regularly under the full brake load, at 15 revs. per min., or 1% of its full speed. While operating at full speed in one direction the motor could be instantly reversed, the reversal being perfectly gradual and entirely without spark or troublesome feature of any kind. In order to get the marked effect in overcoming the momentum of the fly-wheel the brake was taken off, and when the fly-wheel was running at its full speed of 300 revs. per min. the motor was reversed instantly. In 13 secs. the motor had brought the fly-wheel to rest, and in 13 secs. more had it running at full speed in the opposite direction, the entire operation being effected with the greatest smoothness and without any spark whatever. The performance of the motor was satisfactory, and showed its adaptability to any work met in practice.

The Concave Spring Co.'s Works, in Jersey City, N. J., have been purchased by Robert B. Johnston & Co., of New York, and the daily output of railway springs will be much increased by the installation of new machinery and an increase in the working force. Mr. Dallas P. Clark, formerly superintendent of the National Car Spring Co., of Newark, is superintendent of the new establishment.

Companies.—San Diego Iron & Steel Co., of San Diego, Cal.; Wm. P. Shinn, Dr. J. C. Evans, J. T. Neeley and Warren Wilson. Connecticut Smokeless Fuel Gas Co., of Chicago, Ill.; T. G. Hall, L. T. Drury, C. C. Ward; $1,500,000. McDowell Steel Co., of Chicago, Ill.; and South Chicago Steel Casting Co., of Chicago, Ill.; Frederick Arnd, A. P. Evans and Chas. M. Walker; $90,000 and $20,000. Ganley Bridge & Lumber Co., of Ganley, W. Va.; S. M. Straughn, of Montgomery, Ala. Bush Cattle Guard Co., of Kalamazoo, Mich.; metal surface cattle guards; $50,000.

Metal Market Prices.—*Rails.*—New York: $30 to $30.50; old rails, $20 to $21 for iron and $16.50 to $17 for steel; girder rails, $40. Pittsburg: $30; old rails, $23.75 to $24 for iron and $17 to $18.50 for steel. Chicago: $31.50 to $33; old rails, $22 to $22.50 for iron and $14.50 to $16 for steel.

Track Materials.—New York: steel angle bars, 1.7 to 1.9 cts.; spikes, 2.15 to 2.25 cts.; track bolts, 2.8 to 3 cts., with square and hexagon nuts. Pittsburg: splice bars, 1.75 to 1.85 cts. for iron or steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.8 to 1.85 cts. for iron, 2 cts. for steel; spikes, 2.2 to 2.25 cts.; track bolts, 2.7 cts. with hexagon nuts.

Pipe.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 57½ and 47½ per cent. on black and galvanized butt-welded; 67½ and 55 per cent. on black and galvanized lap-welded. Casing, 55 per cent.

Foundry Pig Iron.—New York: $14.25 to $18. Pittsburg: $14.50 to $16.25. Chicago: $14.50 to $16.

Lead.—New York: 4 to 4.1 cts. Chicago: 3.9 to 4 cts. St. Louis: 3.95 to 4 cts.

Structural Material.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles, 1.9 to 2.1 cts.; tees, 2.4 to 2.75 cts.; sheared iron plates, 1.85 to 2.25 cts.; steel plates, 1.9 to 2.15 cts. for tank, 2.15 to 2.3 cts. for shell, 2.4 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2 cts.; tees, 2.6 cts.; universal iron mill plates, 2 to 2.05 cts.; sheared steel bridge plates, 2.15 to 2.2 cts.; refined bars, 1.8 to 1.85 cts.; steel plates, 2.05 to 2.1 cts. for tank, 2.35 cts. for shell, 2.3 to 2.5 cts. for flange, 3.85 to 4.25 cts. for firebox. Chicago: beams, 3.2 cts.; channels, 3.2 cts.; angles, 2.05 to 2.1 cts.; tees, 2.4 cts.; universal plates, 2.12½ cts.; sheared steel plates, 2.2 to 2.25 cts.; steel plates, 2 1 to 2.12½ cts. for tank, 2.3 to 2.35 cts. for shell, 2.5 to 3.6 cts. for flange.